SCIENCE

FRIDAY, OCTOBER 27, 1899.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE HISTORY OF THE BEGINNINGS OF THE SCIENCE OF PREHISTORIC ANTHROPOLOGY.**

I.

CONTENTS.

THE BEGINNINGS OF THE SCIENCE OF PREHISTORIC ANTHROPOLOGY.

Denmark.

Scientific investigation into prehistoric anthropology began in Denmark in the

* Address by the Vice-President and Chairman of Section H, American Association for the Advancement of Science, Forty-eighth Meeting, Columbus Meeting, August 21, 1889.

early part of the present century. Its start was more the result of accident than design. The King of Denmark provided, in 1806, for a scientific investigation of his country, corresponding in some degrees with the aggregate duties with what in our country are the Geological Survey, the Natural History Division of our National Museum and Department of Agriculture, and the Bureau of Ethnology.

Dolmes.

Almost the first obstacle the Committee met, and which, being unable to explain, caused it to put on its studying cap and led to an extensive discussion, was a dolmen, one of the common and now well-known prehistoric burial places. Associated with the discovery were the stone hatchets, both polished and chipped for polishing, also now so well known. The studies of the historian and archeologist failed utterly in assigning any of these to any period or people known in historic times. The ancient Sagas were studied in detail, but never developed an age of culture, wherein axes other than those of iron were used. As the Commission's investigations were extended, the number of these objects, both dolmens and axes, were increased, and other implements were added to the list.

Denmark kept the lead in her interest in the discoveries relating to prehistoric man, and in the formation of the new science which was to become prehistoric anthropology.

Shell Heaps.

Another Commission was formed, composed of Professors Forschhammer, Steenstrup and Worsaae, the latter of whom was the special representative of the Science of Archeology, though the other two would, perhaps, have been equally as great in archeology had they not already been celebrated by their earlier work in biology and geology. Worsaae's labors as an archeologist were overshadowed by his subsequent greatness as a statesman; he became one of the Cabinet Ministers of the Kingdom, and died in office.

The Committee continued the investigations into the new science by the discovery of the shell mounds. That at Havelse was first and became the representative specimen, but it was soon found that shell mounds or deposits existed along the coast in every direction, and what had theretofore been supposed to be the natural surface of the land, was really the result of human labor and the evidence of human occupation. The farmers and land owners in their respective neighborhoods had already discovered that these mounds were not composed of the usual sand and clay, but mostly shells, which, in a state of great decay, were more or less mingled with black soil; and they had carted away much of the material to be distributed over the surface of their fields for enrichment.

An investigation commenced at Havelse, showed not only the artificial character of these shell mounds, but the presence of many pieces of stone, principally flint, which had been broken in such way as to indicate human intervention and an adaptation to human use. These objects ran pretty nearly the entire range of prehistoric implements as we now know them: hammerstones, axes, hatchets, flakes, scrapers, arrowpoints, spearheads, knives, spindle-whorls, gouges, crescents, daggers, etc. There were also objects of shell, horn and bone, and many fragments of pottery.

The more important implements from certain deposits were found to be of stone, with a piercing point or a cutting edge, mostly chipped into shape, though some had been pecked or battered and then ground or polished.

In other deposits objects of different material were found, and among the rest the presence of bronze implements was detected.

The number and kind of these implements, their methods of burial or deposit, with the associated objects, enabled the archeologist to assign to them a chronological sequence; first in epochs of culture, and second in improvement made within these groups.

These epochs of culture divided themselves according to the material employed for cutting implements, into the ages of stone, bronze and iron. This was the first step in the establishment of the new science of Prehistoric Anthropology. The Royal Danish Museum of Antiquities was established in 1816, now occupying the Princessen Palace at Copenhagen. It was to be the home of the archeological collections of the Kingdom, and here Mr. Thomson with the aid of Professors Forschhammer and Steenstrup, classified, arranged and displayed the objects found, and here the new science was born.

Lake Dwellings.

In 1853 and 1854 the waters of the Swiss Lakes were from natural causes reduced to a low stage, and Dr. Ferdinand Keller employed the opportunity to investigate certain peculiarities which, reported to him by the fishermen and builders on the water's edge, had excited his curiosity. One of these was that certain localities, with a sloping shore apparently well suited for drawing the seine, were rendered useless for this kind of fishing because of obstructions believed to be decayed stumps of a submerged forest covering the bottom, catching the lead-line which had to be lifted, the lifting of which allowed the fish to escape. It appeared that excavations had been made during a period of comparatively low water, in the year 1829, as for a building, wherein the piles and other objects of great antiquity, believed to have been Roman, had been found. Being thus satisfactorily accounted for, their discoverers gave them no further heed, and the objects were not brought to the attention nor submitted to the inspection of any antiquarian. Dr. Keller's first surprise was at the number of these stumps, the similarity of their appearance, and the regularity with which they had grown. His surprise was increased when, on lifting one out from its bed, it was found *not* to be a stump, but a sharpened and pointed pile-bearing evidence of human workmanship, which had been driven into the ground. A cursory examination showed this to be the condition of all. This was evidence of a previous human occupation; and as the late discovery in Denmark began to have its effect upon the mind of Keller, it became apparent that these were the evidences of a human occupation of the Swiss Lakes at some prehistoric period. This ripened into a certainty when it was discovered that like conditions existed in other places, not only in Lake Zurich, but in divers other of the lakes. Reports of these from both Switzerland and Denmark, spread over western Europe and naturally excited the interest and curiosity of many thinking men, especially those of France and England. The objects themselves were passed about, and descriptions of them with illustrations were brought under the eyes of the people of these countries, who turned their attention to similar known objects of their own countries theretofore unrecognized. Like the discoveries in Denmark and Switzerland, the great interest centered in the similarity of the respective implements in the various classes found in these widely-separated countries. If I recur to this question of the similarity of implements found in different countries, it is because of its importance. It formed the foundation of the science. It was by reason of this similarity that the Scandinavian discoverers and early students were able to determine the prehistoric ages. By comparison of imple-

ments of their own countries with those of Scandinavia, and a recognition of the similarity between them, the students from other countries of Western Europe were enabled to correlate and identify the culture of the prehistoric man; and this knowledge finally crystallized into the universal recognition of the three prehistoric ages of stone, bronze and iron. The prehistoric man had but few kinds of implements: the hammer or maul, the hatchet, the knife, scraper, arrowpoint and spearhead, spindlewhorl, points of bone and horn, objects principally ornaments, of shell and pottery. These implements were substantially the same in every locality so far as concerned the Neolithic period. The polished stone hatchets were identical whether found in the dolmens of France and England, the dolmens and shell heaps of Scandinavia, the lake dwellings of Switzerland, or the terramare of Italy; and in after years, as our knowledge of the prehistoric world increased, this similarity was found to extend throughout the Eastern and Western Hemispheres, as well as the islands of the sea. The similarity was not confined to one class of implements, but included nearly all in every age. To be sure, there were minor differences, but the implements could be recognized as the same whenever found. For example, the hatchets were long or short, had a head or poll, well finished or left rude, and were round, flat or square in section. Those square in section were from Scandinavia; short stumpy ones with unfinished poll, from the British Islands; the poll pointed or rounded and well finished, from Continental Europe; the button-headed, from Brittany. But with all this, they were always the same implement. The material might differ with the locality, but otherwise, as to use and method of manufacture, they appeared the same. As investigation proceeded, this similarity of implement extended. The polished stone hatchet of America was found to be the same, with the same differences of detail; some from Illinois, made of flint, have a spreading edge, almost of a crescent form, the corners forming the points after the style of some of the battle-axes of medieval knights; those from Chiriqui are flattened on both sides by a sort of chamfer which makes them appear hexagonal in section. It has been argued that this similarity of implement was due to the similarity of human thought adapted to human necessity. The similarity of human thought and action under the same necessities may be admitted, although it necessarily had its limitations.

The similarity of the implements found among different peoples widely separated, is not accounted for by the theory of human thought and human needs. The classification of prehistoric culture into ages of stone, bronze and iron was based on the similarity of the implements in each age found in the respective countries, and this was the result of migration, communication or contact between the peoples.

Discoveries of Darwin and Boucher de Perthes.

By the middle of the century students of prehistoric matters of the Old World had about accepted the prehistoric ages of stone, bronze and iron. Some attempts were made to discover the man who had made and used these implements; and the few skulls that had been gathered in earlier times, the significance of which had not then been understood, were subjected to reexamination in view of the new light upon prehistoric matters. Chief among these were the Canstadt skull, discovered in 1706, and the Engis skull, in 1822. In these studies the pathway of prehistoric science and knowledge was being slowly blazed when, in the year 1859, two great discoveries relating to the origin and antiquity of man were published which had something

of the effect of an earthquake upon former scientific conclusions. One, the origin of the human species through evolution, by Darwin; and the other, the acceptance as artificial of the paleolithic implements found by M. Boucher de Perthes in the valley of the Somme. Boucher de Perthes had, as early as 1836, but seriously since 1841, been investigating the peculiarities of certain chipped flints found at Abbeville, France, as far south as Amiens, along the line of the canals and railroads then in course of construction. These he had recognized as the work of man, and claiming for them the highest antiquity, he asserted them to be antediluvian. His discovery was at first unfavorably received. In 1853 Dr. Rigollot announced his adhesion to the theory; in 1859 Dr. Falconer discovered the presence of the bones of *Elephas antiquus* at St. Acheul, and their association more or less intimate with the chipped flint implements of Boucher de Perthes. In 1859 numerous geologists of England visited the locality and some of them, especially Mr. Arthur J. Evans, now Curator of the Ashmolean Museum, Oxford, then a lad accompanying his father, Sir John Evans, had the good fortune to find one of the chipped flint implements *in situ*. There was much contention over the proposition connecting man with these implements, and there were many unbelievers. Some disputed the antiquity of the deposit, others the human manufacture of the implements and, curiously enough, the greatest opposition came from the French geologists and the greatest support from the English. It is not here declared that the geological formation was not early understood by eminent scientists who visited the locality, but there does not appear to have been any publication *in extenso* of that formation and the strata of which it is composed and the fauna found therein, until that of M. D'Ault Du Mesnil in the *Revue Mensuelle de l'Ecole d'Anthropologie* (Sixieme Année, IX., 1896), and of which I translated and published the general portions in the *American Antiquarian* (Vol. XXI., No. 3, 1899, pp. 137–145).

There were found to be several geologic and paleontologic strata. In the lower layers the bones and teeth of *Elephas meridionalis* were found associated with the *Rhinocéros merkii;* in the middle strata the *Elephas primigenius* and the *Elephas antiqusu* were mingled; while in the upper layers the *Elephas primigenius* alone appeared. The implements in the lower strata were large and rude, while in the upper they became smaller and finer and better made, forming the type called by M. D'Ault Du Mesnil, St. Acheulléen. The surface layer contained objects belonging to the later ages, and does not here concern us. The discussion over the theory of the human origin of these implements soon came to a close by its general acceptance. There have been continuous and almost illimitable discussions over details, but none over the general proposition. 'One swallow does not make a summer,' and a single discovery, either of an implement or a locality, is of slight value in the establishment of any general proposition in prehistoric anthropology. If the discovery of chipped flint implements had been confined to those of Boucher de Perthes, they never would have made any headway. But the attention of those interested in the subject having been attracted to these chipped flint implements, they were, as the polished stone hatchets in the Neolithic period had been previously, found in greater or less numbers in many localities throughout the principal countries of western Europe. Then came a comparison of the same implements from different localities, and it was decided that they were related and formed a stage of culture so different from that of polished stone as to show that they

belonged to another people occupying the country at an earlier date. To this period Sir John Lubbock gave the name Paleolithic.

These chipped flint implements were found by scores of investigators and searchers in hundreds of places, to the number of tens of thousands.

As before remarked, it was the likeness or similarity of the implements, not only in general form, but in the details, as well as in their material, mode of manufacture and possible method of use, which clinched the argument. They so closely resemble each other in the details as to show to the student that the men who made and used them not only belonged all to the same stage of culture, but that either through migration or commerce they must have had intercommunication. They might or might not have been blood-relatives, but that they were really acquaintances and taught each other the modes of fracture of these implements, seems to have been admitted on all hands.

The discoveries of the prehistoric ages of stone have been extended to Africa. Professor H. W. Haynes and General Pitt-Rivers in Egypt and Mr. Seton-Karr in Somaliland, have made discoveries of paleolithic implements. Discoveries of neolithic implements have been made by Mr. J. de Morgan in the valley of the Nile, and by a Belgian, in the valley of the Congo. All have been found in sufficient numbers to establish the fact that they were not isolated or sporadic specimens but were evidence of an extensive human occupation of their locality.

Differences Between Paleolithic and Neolithic Cultures.

In treating of the science of prehistoric anthropology, it is imperative that the differences between the culture of paleolithic and neolithic times should be noticed. Necessarily this must be confined to the Old World, as the discoveries in America have not been sufficient to establish the lines between the two periods.

Mons. Gabriel de Mortillet formulated the differences between his Madelainien epoch (the last of the Paleolithic period) and his Robenhausen epoch (the first of the Neolithic period), and has arranged them in parallel columns that they may make a graphic representation :

LATEST PALEOLITHIC	EARLIEST NEOLITHIC.
(1) Climate cold and dry, with extreme temperatures.	(1) Climate temperate and uniform.
(2) Existence of the last grand fossil species—the mammoth.	(2) The mammoth extinct.
(3) Chamois, marmot, the wild goat in the plains of France.	(3) Chamois, marmot, and wild goat have gone to the summits of the mountains.
(4) Reindeer, saiga (antelope), elk, glutton, white bear, in the center of Europe.	(4) These animals have emigrated toward the Arctic region.
(5) Hyena and the grand cat tribe.	(5) No hyenas or grand cats.
(6) No domestic animals.	(6) Domestic animals abundant.
(7) Human type uniform.	(7) Human type much varied.
(8) Population nomadic.	(8) Population sedentary.
(9) Hunters and fishes, but no agriculture.	(9) Agriculture well developed.
(10) Stone implements always chipped.	(10) Stone implements polished.
(11) No pottery.	(11) Pottery.
(12) No monuments.	(12) Monuments: Dolmens and menhirs.
(13) No burials; no respect for the dead.	(13) Burial of the dead.
(14) No religious ideas.	(14) Religious ideas well developed.
(15) A profound and pure artistic sentiment.	(15) No artistic sentiment.

The radical difference between the Paleolithic and Neolithic periods, and one to be first remarked, was that they were in different geologic epochs. The former belonged to the quaternary, the latter to the present epoch. In the transition from the Paleolithic to the Neolithic the glaciers ceased, the climate became temperate and

uniform, the animals peculiar to the earlier conditions passed away and others affected by the change of climate migrated. There were eighteen species of cold-loving animals in western Europe during the Paleolithic period which migrated to other localities because of the moderation of the temperature incident to the commencement of the Neolithic period. Thirteen of these migrated to cold countries by latitude going to the north, the reindeer, the musk-ox, the blue fox, etc.; five like the chamois and mountain goat, migrated to cold countries by altitude, going up on the mountains.

Comparing the industries of the two periods, we will see some of those of the earlier, continued into the later periods, and some of those the later were invented or improved.

The art of chipping stone into implements was continued from the earlier to the later but to it was added the art of grinding and polishing. All our smoothed and polished stone implements and objects had their origin in this neolithic culture. Sawing and drilling stone began here. The bow and arrow, the first projectile machinery in the world, here had its birth.

The twisting of flaxen thread, weaving and the making of cloth, clothing, commenced in this period. Pottery making was begun which, in itself, wrought a revolution in human culture. The earliest monuments of the world, the great mounds, tumuli, dolmens, menhirs, cromlechs, and the fine specimens of prehistoric architecture, date from this period.

The family was formed, and the clan or tribe organized with a local habitation and a name. Villages, and finally towns were established; animals were domesticated, flocks and herds with farms and pastures came into being; agriculture increased the means of subsistence; a division of labor became fixed, and mechanics with trades were partially inaugurated. Though the neolithic man, from our point of view, was a savage, yet compared with his predecessor, the paleolithic man, he made a long stride towards civilization, whether from savagery to barbarism may be suggested but need not be decided, nor even argued here.

Paleolithic Implements Employed.

The recognition of the artificial character of the chipped flint implements found by Boucher de Perthes, and the many who came after him, and which gave an impetus to the science of prehistoric anthropology, made an opportunity, if it did not create a necessity, for some sort of classification. The Scandinavian classification of stone, bronze and iron had been accepted, but these late discoveries demonstrated an earlier period and called for a subdivision of the age of stone.

All the implements found were of flint and chipped. During this period man did not know how to rub one stone against another to make either of them smooth or sharp, as he did in the later age; so the first was called the chipped stone age, and the other the polished stone age. Sir John Lubbock gave them the names, respectively, Paleolithic and Neolithic. These paleolithic implements of chipped flint being found mostly in the alluvial gravels, the name alluvial, alluvium (French), diluvial, diluvium (English?), were respectively given them.

These implements and the period to which they belong require a description by which they can be recognized from those of other ages. They were all of flint or some chippable material, many of them were made from boulders or concretions. Some were so chipped as to leave the smooth part of the boulder as a grip for the hand. They varied in length from six or eight inches down to three, in width from five to two, and in thickness from three inches to one.

They were generally almond-shaped and had a point or cutting edge at the small end; some of them made from ledge-rock and not from boulders, were brought to an edge all round. In outline they resemble the leaf-shaped implements of later ages; but when viewed edge-wise the difference was manifest in that these were much thicker. The thickness is usually about half their width; an implement four inches wide would be about two inches thick, and one two inches wide, an inch thick, while leaf-shaped implements of that width would not be one-half as thick.

River Drifts, Valleys and Terraces.

A further explanation is as to the formation of the geologic deposits in which the implements were found, and so a decision as to their geologic age. It is believed that at an earlier period in the geology of the country the water of the rivers on its way to the sea eroded the earth (as is shown by the geologic models, principally of the Rocky Mountains, in the U. S. National Museum) and formed valleys, making them reach from one hill to the other and as deep as the present bottom of the rivers; at the second stage the water in the rivers, becoming less in volume and slower in movement, began the process which has been carried on from that day to the present in all river valleys, the cutting or washing of the river bank at or from one point or locality where the water ran swifter and stronger, and carrying it further down the stream where the water ran slower and weaker. In this manner the river terraces were formed, each successive terrace, counting from the hill, represented a corresponding abasement of the water, until, as at present in many of our American rivers, especially the Ohio, three terraces exist on either side of the stream. In the chronologic formation of these terraces, that nearest the hill was the oldest, that nearest the stream the latest. The bottom of each terrace was, naturally, laid down first and, consequently, was older than the top. So the bottom of the first terrace (nearest the hill) was the oldest, and the top of the terrace (that nearest the stream) was the latest.

These paleolithic implements have been found in the bottom of the first terrace and, consequently, were a part of the earliest deposit. And as they continued throughout the various terraces and in the different parts thereof, it is believed that the Paleolithic period in these localities began with the formation of the river-valleys and is coexistent with them.

During all this period no implements of less enduring material than flint have been found, if any ever existed. No human remains have ever been found in the river valleys; nor the remains of any animal so small as man or whose bones were so light and frail as are his.

Differences in Climate.

No traces have been brought to light of either the habitation or the raiment of the man of this period. It has been suggested that he had no need for either. The climate was warm, moist and rainy; he required neither dwelling nor raiment to keep him warm or dry, for, like the savages of warm climates generally he may have preferred to run naked. This is regarded as entirely feasible in the climate then prevailing in western Europe.

But there came a change, supposed to be represented by the glacial epoch, when the climate became cold and wet, and man required protection and so was driven to the caverns for shelter. Here is found the first evidence of raiment. Thus began what has been called the cavern period.

Epochs of the Cavern Period.

Different classifications have been made and different names given to these. Some

of the early scientists named them for the animals of the time and locality. Lartet named them respectively, Cave Bear, Mammoth, Reindeer, and Ox; Dupont, Mammoth and Reindeer. The English generally employed the terms 'river-drift' (for the earlier, paleolith) and 'cavern.' De Mortillet made an exhaustive study and a consequent elaborate classification named for, and based on the industries found in certain localities: The Chelléen after Chelles (Seine-et-Marne), Acheulléen after St-Acheul (Somme), Mousterien after the cavern of Le Moustier (Dordogne), Solutreen after the station of Solutré (Sâone-et-Loire), Madalenien after the rock-shelter of La Madeleine (Dordogne), and Tourassien after La Tourasse (Haute-Garonne), the last representing the hiatus between the Paleolithic and Neolithic ages. This classification was carried throughout the prehistoric ages.

Objection may be made to the nomenclature of this classification, but a slight experience will satisfy one of its excellence. Its principle is to give an epoch of culture the name of a locality where that particular culture is manifested in its greatest purity. This may be an arbitrary system, but it has the great desideratum of all systems of nomenclature—certainty and definiteness. By such, one knows exactly what is meant, and this is the chief purpose of nomenclature. The American geologic classification is based largely on the same system.

High-Plateau Paleoliths, Ightham, Kent.

Among many discoveries of paleolithic implements in Europe was a certain class which indicated a human occupation earlier than those found in the river gravels. These belong to the high plateaux between the headwaters of the streams. The principal discovery of implements of this class was by Mr. Benjamin Harrison, of Ightham, Kent; but knowledge of the significance thereof is due to the great geologist, Professor Joseph Prestwich.

Mons. de Mortillet's classification of prehistoric chronology, as applied to France.

TIME.		AGES.	PERIODS.	EPOCHS.
Quaternary—Actual.	Historic.	Iron.	Merovingian.	Wabenien (Waben, Pas-de-Calais).
			Roman.	Champdolien (Champdolent, Seine-et-Oise). Lugdunien (Lyon, Rhone).
	Protohistoric.		Galatian.	Beuvraysien (Mont Beuvray, Nievre). Marnien (Department of Marne). Halstattien (Hallstatt, Austria).
		Bronze.	Tsiganien.	Larnaudien (Larnaud, Jura). Morgien (Morges, canton of Vaud, Switzerland).
Quaternary—Ancient.	Prehistoric.	Stone.	Neolithic.	Robenhausien (Robenhausen, Zurich, Switzerland). Campignyen (Campigny, Seine-Inferieure). Tardenoisien (Fère-en-Tardenois, Aisne).
			Paleolithic.	Tourassien (La Tourasse, Haute-Garonne) Ancient hiatus. Madelainien (La Madeleine, Dordogne). Solutréen (Solutre, Saine-et-Loire). Moustérien (Le Moustier, Dordogne). Archuléen (Saint-Achuel, Somme). Chellèen (Chelles, Seine-et-Marne).
Ter-t'ry.			Eolithic.	Puycournien (Puy-Courny, Cantal). Thenaysien (Thenay, Loire-et-Cher).

A small stream runs past the town of Ightham where it joins the Medway. This stream has the usual terraces in its valley which, like other terraces, are formed of river drift. These valleys contained paleolithic implements of the usual kind similar to those heretofore described. The theory was, that the river-valley had been eroded, the sand and gravel cut or washed away, then carried down the stream and deposited where the current became weaker; thus would be involved all the paleolithic implements within the scope of the valley or ravines that fell into it. The information furnished by Mr. Harrison's discovery was that, on the high plateau levels *not* involved in the valleys or the ravines leading to it, the same kind of paleolithic implements were found practically on the surface. The theory of Professor Prestwich founded on Harrison's discovery carries us back one step further in the chronology of paleolithic man. He believed that the implements were made and used by man on these high plateaux before the commencement of the formation of the river-valley; that, being scattered over the surface where they had been left by their owners, they have remained until now found undisturbed, uninfluenced by the erosion, the which as it proceeded, cut away the sand and gravel and drew the the other implements into the valley or into the general current which carried the sand and gravel down, and deposited them with the débris in the form of a terrace. These Harrison implements *not* being within the reach of this erosion, remained *in situ* and are now being found on the surface of the plateau above. Implements, and even workshops indicated by the presence of certain tools and style of implements, remained on the high plateaux and are there found to-day. If they had been within the influence of the stream and had been carried down by its waters, they would have been found in the drift of the terrace below; but not having been thus involved, they were not affected and so remained in their original places until now found. This conclusion, if correct, pushes the paleolithic one epoch farther into the past; instead of the implements being found in the bottom of the river terrace at the completion of their journey, they are found on the high plateau which was originally, and for the others, the beginning of the journey.

Tertiary Man.

Another step in the science of prehistoric anthropology (whether forward or backward is yet to be determined) was the discovery of implements and objects of supposed human origin, or which bore a supposed artificial character, alleged to be evidence of man's existence in the tertiary period. The first report in this direction was by Mons. J. Desnoyers who, on June 8, 1863, presented before the Academy of Sciences at Paris, certain fossil animal bones and pieces of wood, from the quarries of sand and gravel at Saint Prest, near Chartres, France, which were believed to belong to the pliocene formation, whose marks, imprints and striæ were such as could have been made by man and were, therefore, said to be evidence pointing towards his existence in that period. In 1867 the Second Congress of Archeology and Prehistoric Anthropology met at Paris and was largely occupied over a presentation of, and discussion upon the evidences of tertiary man. Mons. L'Abbé Bourgeois presented a series of flint objects which were so chipped or broken as to appear to have been done by man. Other objects were presented by various persons, all alleged to have a bearing upon the main question and tending to establish the existence of man in the tertiary period. These were of different materials: bones cut or marked, teeth or bones drilled, wood and bone carved or gnawed, etc., until a rather

extensive series of objects was gathered and which, if their finders could have successfully maintained, would have gone far toward the establishment of the existence of man in the tertiary period.

Professor Capellini found the fossil rib-bones of a whale in the tertiary deposit at Monte-Aperto, Italy. These ribs had evidently been cut with a sharp knife or tool and might easily have been done by man. There was no attempt at engraving, only certain kerfs across the ribs. Professor Capellini presented his discovery to the Academy of Lincei at Rome, and before the Congresses of Archeology and Prehistoric Anthropology at Budapest in 1876, and at Paris in 1878. I had the pleasure of examining these specimens in the Museum of the University of Bologna, and was much impressed with the contention of Professor Capellini.

Dr. Arturo Issel, one of the leading scientists of Genoa, joined the advocates of tertiary man before the International Congress of Archeology and Prehistoric Anthropology in 1867, by the presentation of a human skeleton, or a portion of one, found at a depth of ten feet in the blue clay, said to have been of pliocene formation, near Savona, Italy. The skeleton was discovered by other persons and had been distributed and portions lost, so that only certain members came to Dr. Issel. There were no other animal bones found in the deposit, but many fossil shells which undoubtedly belonged to the pliocene. If the skeleton was contemporaneous with the original deposit it would be good evidence of the existence of man during that period. Four human skeletons were found at Castenedolo, Italy, by Professor Ragazzoni, then searching for fossil shells. The deposit was determined to belong to the pliocene, or at least to the tertiary.

There were throughout western Europe, perhaps a dozen more instances of objects alleged to be human or related to human, found in tertiary deposits. The principal of these, and that which obtained the greatest prominence, was the discovery of Abbé Bourgeois at Thenay near Pontlevoy (Loire-et-Cher). Among other reasons for the prominence of the discovery of Abbé Bourgeois was the fact that the discovery was near his own residence, where he could give it much of his personal attention; and he was able to attend many or all of the scientific meetings, whether of archeology, geology or paleontology, wherein the subject would find interested auditors, with many opportunities for the presentation of the subject. From the year 1867, when his discovery was presented to the International Congress of Archeology and Prehistoric Anthropology at Paris, until 1883, before the Association Française at Blois, he kept up an aggressive warfare. The deposit at Thenay was agreed to belong to the tertiary, and it had not been disturbed; therefore, if the objects were made by man, they would be evidence of his existence at the time the deposit was made. They were all of flint and had evidently been worked; whether naturally or artifically was the important question. Some had been crackled as though by fire, and others had been chipped as though by man. I have three of these pieces of flint in the Museum at Washington, and am free to confess that, had they been found under conditions ordinarily possible to prehistoric man, I should have no hesitation in accepting them as artificial. The presentation of these flint objects before the various archeological Congresses created great interest and begat much discussion. At one, that in Brussels, an international committee of fifteen members was appointed to investigate the question and make report. The committee divided, as might have been expected. Eight members were of opinion that the pieces of flint were artifically

chipped: DeQuatrefages, Capellini, Worsaae, Englehardt, Augustus W. Franks, Valdemir Schmidt, D'Omalius and Cartailhac;* five members were opposed: Steenstrup, Desor, Neiryuck and Fraas; Marquis de Vibray was favorable but with reserve, and Van Beneden unable to decide.

It will thus be perceived that the question was difficult to determine, and much could be said on both sides. If the opposing forces of learned men who, on the ground, marching in the presence of each other and of the objects themselves, and, as at Blois, with the deposit whence the objects came, under their eyes, were still unable to determine the question, it would be venturesome for us to attempt it. Since the meeting at Blois, there has been but little discussion of the flints from Thenay. It would seem as though neither party was convinced by the other, and both were content to maintain their former opinions and cease the discussion. Sir John Evans revived it after a fashion in his presidential address before the British Association at Leeds in 1890, wherein he took opposite grounds.

Discoveries similar to that of the Abbé Bourgeois were made by M. B. Rames, a distinguished geologist of Aurillac, at a locality called Puy Courny near Aurillac; by Charles Ribeiro near Lisbon, Portugal; and by Joseph Bellucci of Perugia, at Otta, Monteredondo, Italy. They all fall into the same category and received the same treatment. In the conclusion to be awarded to the existence of man during the tertiary period, they stand or fall together.

Pithecanthropus—Dubois.

The presentation of this branch of my subject would be incomplete without a reference to the great discovery made by Dr. Dubois at Tinil, Java. Dr. Dubois is an educated physician, a graduate of the Leyden University, interested in prehistoric anthropology, with a sufficient knowledge of geology and paleontology to enable him make satisfactory investigations in the field. He was attached to the Dutch army as a medical officer, and with it sent to Java. He lived there for six years, and having found a deposit of fossil bones at Tinil, prosecuted his researches therein for three summers with great success. During this work he found certain portions of a skeleton which, if not human, was nearer it than was any other. Dr. Dubois has published a preliminary report of his discovery containing a section and plan of the field of his explorations, and photographic copies of the human (?) remains. When this publication appeared and fell into the hands of the physical anthropologists, whether of Europe or of America who, by their knowledge of human and comparative anatomy, were the best qualified to judge, they almost universally settled the question to their own satisfaction in the shortest and easiest way, by the decision that the remains were human and that Dr. Dubois had done nothing more than discover an ancient graveyard. There were few persons in the United States prepared to combat this view. Professor O. C. Marsh visited Leyden in attendance upon the International Congress of Zoology, September, 1895, and upon his return announced that this was a much graver question than had before been recognized.

I had the gratification of visiting Dr. Dubois and seeing his collection. Like Professor Marsh, I was amazed at the showing made. He had, in his laboratory, many thousand pieces of bones from the deposit at Tinil. They were all fossilized, their weight was greatly increased, and their color much darkened, while the human (?) bones had an identical appearance, and it was evident that they came from the

* Mons, Cartailac changed his opinion, but not until several years afterward.

same deposit and were the same age. It is the accepted conclusion on every hand that the bones and deposits belonged to the tertiary period; what particular epoch, I am not prepared to say.

The dilemma presented by the discovery of Dr. Dubois in relation to the antiquity of man is that, if the bones are really those of a human individual, it carries the antiquity of the human species back to the tertiary period. If the individual is not human, because the deposit of the tertiary period is too early, then he must have been the precursor of man and, so the 'missing link.' This dilemma must be recognized and the conclusion made harmonious. Darwin would have accepted this as a representative specimen of his 'missing link.' De Mortillet was of opinion that the animal that chipped the flints of Thenay was not man, but his precursor, which he named 'Anthropopitheque,' or 'Anthropopithecus.' Dr. Dubois has the same idea or theory with regard to the man of his discovery, and he has given it the name 'Pithecanthropus erectus.' The discussion over tertiary man or man's precursor, remains in abeyance. Each of the two parties holds to his respective opinions, *pro* and *con*, and the question awaits further developments.

Neolithic and Bronze Ages Continuous.

If there was a belief in an hiatus between the Paleolithic and the Neolithic ages of Europe, there was no belief in an hiatus between the Neolithic period and the age of Bronze. It seems conceded that there was no appreciable difference in the races of people in western Europe in these two ages. It is also conceded that the stage of culture continued in both practically the same; that all or most of the industries of the Neolithic period were continued into the Bronze age, subject, however, to the natural improvement which came with added experience. The difference between the two ages, then, was the increased facility in performing the function of civilization by reason of having cutting implements of bronze instead of those of stone. The making of bronze was evidently a human invention and has little or nothing to do with a difference in race, nor beyond the benefit or improvement made by the invention, has it much to do with a change in culture.

Copper was easily procured throughout Europe, and implements of that metal were made in neolithic times and doubtless continued to be made in the Bronze age. But the advent of bronze was a totally different affair. Copper did not require casting; it might have been hammered into the desired form and so made into implements, but the knowledge of melting and casting was indispensable to the age of Bronze. Bronze is a mixture of copper and tin in the proportion of eight or nine parts of the former to one of the latter. The question whence came the bronze which was so plentiful throughout Europe has always been one of the problems of prehistoric archeology. The tin necessary for making bronze appears to have come from the country around the Straits of Malacca. The methods of its migration or transportation to Europe, whether the tin was brought over, whether it was melted, mixed with copper and then brought over, both being in the form of ingots, or whether it was cast into implements and then distributed, are facts absolutely unknown, and they probably will always remain so. Prehistoric bronze objects have been found in southern Asia and throughout Europe. The excavations of Dr. Schliemann into the Hill of Hissarlik brought many of them to light. Foundries have been discovered in most European countries; in France nigh a hundred, the latest by Mons. Paul du Chatelier in Brittany. The most extensive one yet found was that at Bologna, Italy. It contained the metal

in all stages of preparation for casting, together with molds and crucibles ready for use. There were (14,000) fourteen thousand pieces of bronze, some in ingots but most of it in wornout implements broken into small pieces suitable for the melting pot.

Epochs of culture in the age of Bronze have been manifested by improvements in style in the hatchets of Southern Europe and the fibulæ of Scandinavia.

Physical Anthropology.

Physical Anthropology, which includes Somatology and Physiology, has received considerable attention at the hands of some of the European anthropologists. Naturally, these sciences are studied at immense disadvantage when confined to prehistoric man, therefore, it has been extended to include savage peoples, and many of the most ardent anthropologists of Europe have studied the somatology and physiology of the savage in the endeavor to obtain even reflected light or knowledge in regard to prehistoric man. There had been a number of skeletons of prehistoric man found throughout western Europe. The instances are rare and isolated where specimens have been found of paleolithic man. The evidence has not always been harmonious, nor has it always pointed in one direction. The Neanderthal skull has been assumed as the representative of the oldest race. Probably a dozen other specimens of human skeletons, or fragments thereof, have been found, all of which are claimed to have belonged to paleolithic man. The following are the best known: Constadt, 1700; Lahr, 1823; Engis, 1833; Denise, 1844; Neanderthal, 1856; Olmo, 1863; Naulette, Furfooz, Solutré, Cro-Magnon, Engischeim, Savona, 1865; Aurignac, Laugerie, Brux, 1872; Mentone, 1872–75; Spy, 1886. Those of the Grotto of Spy, in Belgium, are the best identified and authenticated.

The conclusions to be ventured are, that paleolithic man had a dolichocephalic skull with prominent frontal sinuses; he was short in stature but had heavy bones with strong muscular attachments. He was prognathous, with large and strong projecting teeth which were unusually sound. He had habitually three molar teeth. His legs were crooked, and it has been doubted whether he regularly assumed an upright position.

The human remains found in the caverns, still paleolithic but of the later epochs, indicate an increase in height, size and symmetry. It has been supposed, from comparison of osteologic evidence from the caverns, notably with the Cro-Magnon skeleton, that the Berbers of North Africa and the Guanches of the Canary Islands represent a similar ethnic type.

The neolithic man had a skull more brachycephalic. He was not so prognathous as was paleolithic man; his forehead was higher and squarer, and his brain capacity greater; his teeth were less projecting and not so large as those of paleolithic man. The conditions of human burials in prehistoric times were not advantageous for the present study of the somatology of the individual. The paleolithic man rarely buried his dead, and when he did the preservation and discovery of the skeletons have been largely accidental. The neolithic man buried his dead in great ossuaries and frequently, if not always, subjected the individual to a second burial after the integuments had disappeared. The immediate and direct result is that modern discoveries of these ossuaries find the bones pell-mell, and we are unable to identify those of individuals.

Classification of Races.

Unable to obtain sufficient specimens to enable them to master the science in its relation to prehistoric man, the students of

somatology have, as already suggested, extended their investigations to modern peoples, primitive and savage, hoping for two results: one, incidentally a knowledge of these peoples *per se*, and the other to obtain by comparison a better knowledge of prehistoric peoples. This investigation induced classification of races which have run into infinitesimal details.

There has been much striving among anthropologists for a satisfactory classification of the human race. The item in this classification which seems to have been received with most favor is determined by the cephalic index. This is the ratio between the extreme length of the skull as compared with the extreme breadth, and this compared with the extreme height. Various subdivisions have been made and various names given: dolichocephalic the long-headed; mesocephalic, medium, and brachycephalic, short-headed. Other schemes are according to the character of the hair, running through lophocomi (tufted), eriocomi (fleecy), euplocomi (curly), and euthycomi (straight). Still another classification was that of the dental index by Professor W. H. Flower, the microdont (the lowest index), mesodont (medium), and megadont (the highest dental index).

The earliest and possibly original scheme of classification of the human races was according to color: the yellow, white, black, to which were afterwards added the brown and the red. Probably these stand the test of experience in science about as well as the more complicated classifications.

Dr. Topinard has undertaken an investigation among the people of France by which he is to determine the color of the hair and eyes, segregated according to different departments. Virchow has done the same among the school-children of Germany, and in a late work Dr. W. Z. Ripley, of Columbia University, New York, has reported and published sundry investigations in some of the countries of western Europe, classifying and separating the peoples according to color of skin, hair and eyes, of the cephalic index, of height, and other physical characteristics. Such a work as his applied to the native races of America would be new and original and a valuable contribution to the science of anthropology. Dr. Washington Matthews made such an investigation of the early occupants of the Salado Valley, Arizona.

Darwin's discovery of the origin of the human species by evolution from lower forms of animals, created an interest in the antiquity of man different from that of archeology. It required a knowledge of zoology and of human and comparative anatomy, and involved a study of anthropology in its subdivisions of somatology, physiology and psychology, involving the physical and intellectual characteristics of man. Based upon this necessity, the various schools and societies of anthropology were organized in many of the great cities of the world, notably Paris, London and Berlin.

The organization of these societies and the investigations involved brought to the front a set of scientists totally different from those who had before been studying archeology.

Broca, in Paris, stood near the head of these, followed by Manouvrier and Topinard; Gosse in Geneva, Huxley and Tylor, Biddoe and Keane in England, Virchow and Bastian and Meyer in Germany, with Mantegazza and Sergi in Italy. The family Bertillon, consisting of the father (now dead) and his two sons (successors), were the discoverers and inventors of the science of anthropometry in its adaptation to prehistoric man. The races of men had been studied before, and the general divisions were those of color. Anthropometry gave an additional interest to this branch of the science and it ran riot, making subdivisions on the bases of infinitesimal details. This was pressed to such a point

that one ardent investigator found sufficient difference in the human species as that he subdivided it into 172 races.

Anthropology the Science of Man.

Anthropology was defined to be the science of man, and included everything relating to man, his physical, intellectual, psychologic characteristics; and these extended through all ramifications.

Subdivisions of Anthropology.

Some scientists, chiefly the French, have proposed to confine the term 'Anthropology' to the physical structure, but it is deemed better to include within it everything pertaining to man, making the various subdivisions as represented by the minor sciences, even though they might be treated independently. The following is little more than suggestive:

Biology and comparative anatomy.
  Human anatomy.
    Anthropometry craniometry.
Comparative psychology.
  Literature, language (written, oral, sign).
  Religious creeds and cults.
Industry.
  Materials and implements of every craft.
  Clothing and personal adornment.
  Habitations, and household utensils.
  Weapons. Pottery.
  Objects for amusement.
  Articles, uses unknown.
Architecture and fine art.
  Monuments and public works.
  Roads, trails, canals, irrigating, etc.
  Mounds—sepulchral, effigy, altar.
  Forts and earth-w'ks.
  Graves and cemet'ies.
  Idols and temples.
Architecture and fine art —Continued.
  Cliff or cave dwellings.
  Towers, ruined or otherwise.
  Engraving.
  Painting.
  Sculpture.
  Ceramics.
  Decoration.
  Ornamentation.
Sociology.
  Love and marriage, child-life.
  Social organizations, customs and beliefs, pastimes.
  Tribal organization.
  Government, property, law, etc.
  Mythology, folklore.
  Education, relief and charities.
  Mortuary customs and furniture.

The subdivisions made by the Society of Anthropology of Paris, as set forth in the course of lectures given by its professors during the present year, are as follows: Prehistoric Anthropology, Anthropometry and Embryology, Ethnology, Biology, Language and Ethnography, Sociology (history of civilization), Zoologic Anthropology, Geographic Anthropology, Physical Anthropology.

The Society might not accept the foregoing as a correct or complete subdivision of the science. Other branches may be added on the employment of more professors.

The Society of Anthropology at Washington has, during the past year, made the following rearrangement of sections according to what was deemed proper in matter and terminology:

Section A. Somatology,
" B. Psychology,
" C. Esthetology,
" D. Technology,
" E. Sociology,
" F. Philology,
" G. Sophiology.

It will be understood from the foregoing that the subdivisions cannot be made on hard and fast lines, but are susceptible of infinite changes and varieties. It would be scarcely possible for any one to master all these sciences and so become a perfected and all-round anthropologist. Classification, however, is largely a matter of definition; the material facts remain the same. The field of any particular science is well-understood, whatever name may be given or to whatever classification it may belong, and it is not worth while to engage in extensive discussion of any particular classification or the nomenclature or terminology of any of these sciences. It is deemed more satisfactory to group them all under the generic name of 'Anthropology.' This plan has been pursued generally in the Societies of Anthropology and in the edu-

cational organizations where it is pretended to be taught.

United States.

It is my duty on this occasion to give some expression to this subject in its relation to America or to the Western Hemisphere. The length of this address precludes an exhaustive examination. The student or reader might, before proceeding further, read the address delivered before this Section, the first by Dr. Daniel G. Brinton* at New York in 1887, the title being 'A Review of the Data for the Study of the Prehistoric Chronology of America'; and the second that of Dr. C. C. Abbott at Cleveland in 1898, the title being 'Evidence of the Antiquity of Man in Eastern North America.'

The conditions under which the beginnings of our knowledge of prehistoric man were made, were quite different in America from those of Europe. In western Europe the historic period began with the invasion of Caesar, fifty or more years before the Christian era, and the prehistoric period with which we have had to deal came to a close about that time.

On the contrary, in America the prehistoric period continued until the discovery of the country by Columbus, and its subsequent occupation by the white man who was thus brought face to face with the prehistoric man. The superstitions, myths and folklore concerning stone hatchets and flint arrow heads so prevalent in western Europe, had no place in America. It was useless to talk to the white man of the heavenly origin of the stone hatchet or the flint arrow head, when he knew by the evidence of his own senses that these were the implements and weapons of the prehistoric savage with which he had to deal.

THOMAS WILSON.

U. S. NATIONAL MUSEUM.

(*To be concluded.*)

* Died at Atlantic City, July 30, 1899. Resolutions of condolence were adopted by Section H at the meeting after the delivery of this address.

CHEMISTRY AT THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

As has been the custom for several years, the American Chemical Society united with the Section in its meetings, the program on Monday and Tuesday being in charge of the Society and on the other days in charge of the Section. This has resulted very favorably to both parties and never more so than this year when over fifty papers were on the program and the attendance of chemists has been only once if ever surpassed.

The address of the Vice-President, Dr. F. P. Venable, on 'The Definition of the Element,' has already been published in this JOURNAL.

On Monday morning after the adjournment of the general session of the Association, several reports of committees were read. The most important was that of the Committee of the Chemical Society on Coal Analysis. This was presented by W. A. Noyes, the chairman of the committee and was the final report, and took up chiefly the matters of sampling and of moisture. Much discussion was elicited. The reading of papers began on Monday afternoon and continued until Thursday afternoon, when the Section adjourned.

A number of the papers read presented special interest in the field of inorganic chemistry. One of these was by W. R. Whitney on the nature of the change in chromium salts from violet to green on heating. It has of late been quite generally recognized that the chromium salt, say the sulfate, is decomposed on heating its solution into free acid and a more basic salt. The hitherto unsolved problem has been to determine the amount of free acid formed. This Mr. Whitney solved in a very ingenious manner. By enclosing the salt between gelatine walls in a U-tube the acid is made to diffuse, under the influence of an electric current, completely into the jelly,

in which it is easily titrated. The results obtained confirm very completely the correctness of the ordinary accepted theory.

A paper by Louis Kahlenberg, of the University of Wisconsin, on the electrolytic deposition of metals from non-aqueous solutions, dealt primarily with the validity of Faraday's law in such solutions. Experiments with silver nitrate dissolved in pyridin, nitro-benzene, anilin, benzonitril and acetone, and of some other salts in pyridin, show that Faraday's law holds good in these solvents. This is the more striking from the fact that in many other cases non-aqueous solutions do not act like those of water. Kahlenberg also called attention to the fact that from a solution of lead nitrate in pyridin the lead is deposited in bright crystals at the negative pole, while there is no deposit at the positive pole. Silver forms a very dense deposit from solutions of the nitrate in anilin. These latter facts may have some industrial value.

Closely connected with this paper was one by E. C. Franklin, of the University of Kansas, on the electrical conductivity of liquid ammonia solutions, which was a continuation of his work, which has already been noticed in these columns. Professor Franklin described a very ingeniously devised apparatus for purifying the liquid ammonia, particularly from water, and he found that its electric conductivity when thus purified was exceedingly small, not more than one-fourth that of purified water. Many conductivity curves were shown, which resembled more or less closely those of aqueous solutions. Under variable temperature, however, the conductivity increases with the temperature to a maximum and then decreases. This is theoretically the case with aqueous solutions, but the experimental conditions necessary for its demonstration are difficult to obtain.

Note was made in this column a few weeks ago of work which Charles Baskerville, of the University of North Carolina, and others have done on the distribution of titanium. In a paper before the Section, Dr. Baskerville reviewed the work which had been done by others and gave an account of his own work. The most important feature is that every sample of human flesh and bone examined shows the presence of at least traces of titanium. We must consequently consider that titanium is a constant constituent of the human organism, unless, indeed, it militates against Baskerville's work, that only specimens from the negro race were studied. Dr. Baskerville also finds a wide distribution of vanadium, notably in some peats.

A very interesting paper on the relation of physical chemistry to technical chemistry was read by Wilder D. Bancroft, of Cornell, and a most carefully prepared lecture on 'Some Experimental Illustrations of the Electrolytic Dissociation Theory,' was delivered by Arthur A. Noyes, of the Institute of Technology. A word should be added in commendation not alone of the lecture, but also of the idea of having such lectures. It is now the custom of the London Chemical Society to have its annual lecture, and of the German Chemical Society to have them more frequently. The delivery of one or two such lectures before the chemical section, by experts, on subjects about which every chemist wishes to be informed, while few are, would prove one of the most profitable features of the meeting, and it is to be hoped it will be repeated in the future.

Several papers in other fields than that of inorganic chemistry may be noticed. One of the most interesting of these was by H. W. Wiley and W. H. Krug on 'Some New Products of Maize Stalks.' It would have surprised a farmer to see the great variety of materials of which Dr. Wiley showed samples, all made from cornstalks. There was cellulose pith which is now extensively used on war vessels as a backing to armor

plate, from the fact that if pierced by a shot, the cellulose immediately swells and fills the hole, preventing the passage of water; chicken feed and cattle feed of various qualities, one variety containing a large quantity of molasses, and solving the problem of feeding molasses to stock; paper pulp and samples of paper of excellent quality made from it; nitroglycerin absorbents of different grades, giving different qualities of dynamite; superior qualities of nitrocellulose, some for the manufacture of smokeless powder, while from others excellent collodion is formed. Putting this paper with one by C. G. Hopkins on 'Improvement in the Chemical Composition of the Corn Kernel,' one recognizes that not only is corn raising the great American industry, but we to-day far from realize what will be the future importance of this crop. In a paper by M. Gomberg on 'Diazo-caffein,' the intense coloring power of the substance was noted. In another by the same author on the 'Preparation of Tri-phenylchlormethane and Tri-phenylcarbinol,' the synthesis by the use of aluminum chlorid was considered. For the preparation of the aluminum chlorid the author prefers to pass chlorin over hot aluminum, and this is far simpler than the method in which hydrochloric acid is used.

Professor W. A. Noyes contributed a paper on camphoric acid which added materially to our knowledge of this substance, and Professor W. McPherson gave the abstract of an interesting paper on the constitution of oxy-azo-compounds.

Professor H. A. Weber described the method of testing soils for application of commercial fertilizers, in use at the Ohio State University. It consists essentially in taking several samples of the soil, treating them respectively with potash, phosphoric acid and nitrogen, singly and in combination, sowing each with several seeds and basing opinions on the growth of the plants produced.

The estimation of carbon monoxid was considered by L. P. Kinnicutt and G. R. Sanford. In view of the fact that 0.05% of carbon monoxid in the air is dangerous, its detection and estimation is important. The absorption of carbon monoxid by hemaglobin is largely used, but the authors have found better the oxidation of carbon monoxid to the dioxid by hot iodic acid and subsequent titration by sodium thiosulfate.

A paper by Professor T. W. Richards on the atomic weight of calcium gave as the most correct figure at present 40.14.

Although not strictly pertaining to chemistry, mention should be made of the Commers tendered Section C by the Humboldt Verein, of which Professor H. A. Weber is president. The Verein, the Section and quite a number of other invited guests spent the evening enjoying the sumptuous hospitality of their hosts, expressed in thoroughly German style.

A list of the papers upon the program of the Section is appended.

The Nature of the Change from Violet to Green in Solution of Chromium Salts. W. R. Whitney.

Micro-structure of Antimony-tin Alloys. J. J. Kessler, Jr.

The Relation of Physical Chemistry to Technical Chemistry. W. D. Bancroft.

Methods of Analysis of Sulfite Solutions as used in Paper Making. R. de Roode.

The Electrolytic Deposition of Metals from Non-aqueous Solutions. L. Kahlenberg.

Some Experimental Illustrations of the Electrolytic Dissociation Theory (An experimental lecture.) A. A. Noyes.

Improvement in the Chemical Composition of the Corn Kernel. C. G. Hopkins.

Some New Products of the Maize Stalks. H. W. Wiley and W. H. Krug.

Soil Humus. E. F. Ladd.

The Relation of Fertilizers to Soil Moisture. J. T. Willard.

Secondary Heptylamin. T. Clark.

Propane Trisulfonic Acid. W. B. Shober.

Camphoric Acid, Alpha-hydroxy-dihydro-cis-campholytic Acid, and the Synthesis of Dimethyl-cyan-carbon-ethyl-cyclo-pentanone. W. A. Noyes and J. W. Shepherd.

Diazo-Caffein. M. Gomberg.

The Preparation of Tri-phenyl-chlor-methane and Triphenyl-carbinol. M. Gomberg.

The Action of Sodium Methylate upon the Dibromids of Propenyl Compounds and Unsaturated Ketones. F. J. Pond.

Some Secondary Cyclic Amins. C. C. Howard.

On the Constitution of the Oxy-azo-Compounds. W. McPherson.

On Naphthalene-azo-alpha-naphthol and its Derivatives. W. McPherson and R. Fischer.

Esterification Experiments with Hexahydro- and Tetrahydroxylic Acids. W. A. Noyes.

On the Condensation of Chloral with Ortho-, Meta- and Paranitranilins. C. Baskerville.

A Pneumatic System for Preventing the Bursting of Waterpipes through Freezing. N. M. Hopkins.

Note on the Occurrence of Chromium, Titanium and Vanadium in Peats. C. Baskerville.

On the Universal Distribution of Titanium. C. Baskerville.

The Atomic Weight of Calcium. T. W. Richards.

The Iodometric Determination of Small Quantities of Carbon Monoxid. L. P. Kinnicutt and G. R. Sanford.

Preliminary Report on a New Method for the Determination of Carbon Dioxid. M. E. Hiltner.

Analysis of Oils. A. H. Gill.

Examination of Lemon Flavoring Extracts. A. S. Mitchell.

The Composition of American and Foreign Dairy Salt. F. W. Woll.

Notes on Testing Soils for Application of Commercial Fertilizers. H. A. Weber.

The Electrical Conductivity of Liquid Ammonia Solutions. E. C. Franklin and C. A. Kraus.

A Determination of the Transformation Point of Sodium Sulfate. A. P. Saunders.

On the Derivatives of Isuretinic and Formhydroxamic Acid and their Relation to Fulminic Acid. H. C. Biddle.

The Reichert Figure of Butter. J. H. Stebbins, Jr.

The Determination of Nickel in Nickel Steel. G. W. Sargent.

Notes on the Estimation of Total Carbon in Iron and Steel. F. P. Dunnington.

Electrolysis of Metallic Phosphate Solutions. H. M. Fernberger and E. F. Smith.

On the Determination of Volatile Combustible Matter in Coke and Anthracite Coal. R. K. Meade and J. C. Atkins.

Observations upon Tungsten. E. F. Smith.

The Atomic Mass of Tungsten. W. L. Hardin.

Notes on the Determination of Sulfur in Pig Iron. M. J. Moore.

The Chemistry of Rancidity in Butter Fat. C. A. Browne, Jr.

An Electrolytic Study of Benzoin and Benzil. J. H. James.

The Quantitative Estimation of Boric Acid in Tourmaline. G. W. Sargent.

Some Boiling Point Curves. J. K. Haywood.

Electrolytic Determinations and Separations. L. G. Kollack.

The Precipitation of Copper by Zinc. J. G. Shengle and E. F. Smith.

Derivatives and Atomic Mass of Palladium. W. L. Hardin.

Action of Hydrochloric Acid Gas upon Sulfates, Selenates, Tellurates and Phosphates. R. W. Tunnell and E. F. Smith.

The Electrolytic Oxidation of Succinic Acid. C. H. Clarke and E. F. Smith.

The Persulfates of Rubidium, Cesium and Thallium. A. R. Foster and E. F. Smith.

The Chemical Composition of Butter Fat. C. A. Browne, Jr.

Halids and Perhalids of the Picolins. P. Murrill.

JAS. LEWIS HOWE.

WASHINGTON AND LEE UNIVERSITY.

THE COLLECTIONS OF NATURAL HISTORY AT SOUTH KENSINGTON.*

THE collections in the Natural History Museum at South Kensington have recently been considerably enriched by means of exploring expeditions which have brought home from various parts of the world collections of great scientific interest and value. The late Sir William Flower did much to encourage scientific studies on the part of travellers in remote countries, and he was always ready to coöperate in the organization of expeditions and in giving official aid in the determination of collections brought home by explorers. His successor at the Museum, Professor Ray Lankester has lost no time in evincing his complete accord with the ideas of his predecessor in this respect, and indeed it is already evident that he favors a great development of this policy. The fact is becoming more and more generally recognized that it is the business of a national museum of natural history not merely to preserve for scientific study and public instruction the specimens acquired by presentation or by purchase from dealers and others, but to obtain objects by the deliberate exploration of regions which are likely to yield rich harvests of new and important material. This idea has, we are glad to note, been encouraged by the authorities of the Museum. It is seldom now that an important expedition organized by private enterprise leaves these shores without either the explorer himself being in a measure instructed as to the best means of obtaining specimens and supplied with the necessary apparatus for collecting or taking with him one or more trained naturalists.

* From the London *Times*.

The natural history branch of the British Museum benefited greatly by the results of the expedition to Sokotra, which, under the liberal auspices of the Royal and Royal Geographical Societies and of the British Association, was organized by Mr. W. R. Ogilvie-Grant, representing the British Museum, and Dr. H. O. Forbes, director of the Liverpool Museum, with the generous aid of the committee of that institution, for the purpose of investigating and making collections of the natural history of that island. Dr. Forbes will, we believe, give an account of the geographical results of this expedition in Section E at the forthcoming meeting of the British Association at Dover. As regards its zoological work, which was its main object, the general results can be described as most successful. Sokotra does not seem to be rich in its mammal fauna. Only one mammal was recorded from it before Messrs. Forbes and Grant explored the island. They, however, obtained eight distinct species, including a wild ass, goat, Arabian hare, rat, two species of bat, and the Arabian baboon, of which two living examples were brought to England for the Zoological Gardens. The avifauna is very rich, as many as 62 species, represented by nearly 600 specimens, being secured. Eight of the species were new to science. Twenty-three species of reptiles, represented by 350 specimens, 8 of the species being new; 20 species of marine fish, represented by nearly 60 specimens, and large collections of land shells and insects containing many undescribed forms were also included in the harvest. The butterflies are especially numerous, several of the species being very beautiful and hitherto unrecorded.

Another expedition which has yielded results of considerable geological and zoological interest is that undertaken this summer by Dr. J. W. Gregory, of the Department of Geology, to the West Indies, special leave of absence being granted to him by the trustees. The particular object of Dr. Gregory's journey was the examination of the geology of the island of Antigua, but in the course of his voyage he visited such little-explored and out-of-the-way islands as Anguilla, Barbuda, and St. Kitts. The first-named was once a flourishing British colony, but is now derelict by whites. During his stay on this islet Dr. Gregory made a collection of fossils and of the fauna of the place which promises to be of remarkable interest and quite new to the Museum. He also brought back a very large series of specimens from other West Indian islands, and obtained *data* which will enable him to make an important contribution to our knowledge of their geological history.

The Museum availed itself of the opportunity of making some acquisitions of particular interest by means of the expedition sent out by the Hon. Walter Rothschild to the Galapagos Archipelago, off the coast of Ecuador. The fauna of these islands is a rapidly expiring one. Many of the species of birds discovered by Darwin during the voyage of the Beagle, no longer exist, having been exterminated by the convicts who, to the number of about 200, are sent to work on the Galapagos. The giant tortoises peculiar to the group have almost disappeared. Dr. Günther has told us that at the time of the discovery of this archipelago, in the 16th century, the tortoises were distributed in immense numbers over most of the islands; they are now restricted to three only—Albemarle, Duncan, and Abingdon. A search in which four persons were engaged for ten days, rewarded Dr. Baur, who visited Albemarle, the largest island of the group, in 1891, with the capture of five adult specimens. The Museum obtained four very fine examples of this interesting and rapidly diminishing type of *Chelonian*, generally known as 'gigantic land tortoises,' besides a series of five hundred birds and a large collection of reptiles as its share of part of the results of the Rothschild expedition.

The ornithological section has just been enriched through the generosity of Mr. Weld Blundell and Lord Lovat, who have presented to the trustees the very fine collection of birds made by them during their recent adventurous journey in Abyssinia. In the course of their travels through the Galla country and Southern Abyssinia they passed over about 300 miles of country which had never been previously explored. The collection, which consists of 530 specimens, has not yet been thoroughly examined, but the ornithologists of the Museum, Dr. Bowdler Sharpe and Mr. Ogilvie-Grant, are already convinced that it is of very great interest. It includes 234 species, at least 18 being either new to science or not represented in the Museum series. The remarkable feature of this collection of Abyssinian birds in the extraordinary number of species obtained as compared with the number of specimens—a fact which says much for the discrimination of the explorers, who, being handicapped by want of cartridges, had to be cautious in not wasting shots. An idea of the prolificness of the country in bird life may be gathered when it is stated that on entering a new valley the two travelers, having already obtained over 200 species, secured a starling, two small finches, a kingfisher, a reed-warbler, a swallow, and a weaver, all new to their collection and six of the birds not even seen before. The value of the gift is much enhanced by the perfect manner in which the skins were prepared for the cabinet. Credit for this must be given to

Mr. Harwood, the taxidermist who accompanied the expedition and by his work materially assisted Mr. Weld Blundell and Lord Lovat in forming so fine a series of birds.

The mission despatched to Sierra Leone by the Liverpool School of Tropical Diseases for the investigation of malaria may be expected to send home some interesting specimens. Mr. E. E. Austen, the dipterologist of the British Museum, is a member of the party. He will, of course, give most attention to the special objects of the mission—the connection of malaria with mosquitoes—but, besides collecting these winged insects and acquiring valuable knowledge as to their habits and life histories, he will endeavor, as far as possible, to make collections of other groups, some of which are very incompletely represented in the Museum. With reference to this question of mosquitoes and malaria it may be added that, owing to the official steps taken by the Colonial Office, the Foreign Office, the India Office, and the missionary societies, the British Museum will soon be in possession of a unique collection of these insects. As a result of the official circular issued on the subject, hundreds of mosquitoes have, we are informed, already arrived at the Museum from every part of the British Empire, and these are belived to be only a very small portion of the consignments which are to follow in course of time.

SOME NEW DATA FOR CONVERTING GEOLOGICAL TIME INTO YEARS.

WHILE conducting the Union Pacific Expedition through central Wyoming last August, I came upon what appears to be some valuable data for converting geological time into years. For a number of days we were encamped on the rim of Bates' Hole, near Lone Tree Cr., and studied the Miocene beds, which are quite extensive in that region. Bates' Hole is a vast depression produced by the erosion of Tertiary beds and varies from six to twelve miles in width, and approximates twenty miles in length. In depth it varies from 500 to 1500 feet below the rim, and is one vast expanse of rough and broken country, surrounded by bluffs so precipitous that up to this late date there has been but a single wagon road made to enter it from the southern end; and this is far from being ideal. The bluffs that surround this very singular depression take on all of the peculiar erosion topography seen in the 'Bad Lands' elsewhere, and in many respects surpasses any of the 'Bad Land' scenery yet described. The Miocene beds are made of whitish bands chiefly and in the vicinity of Lone Tree Cr., there are many slopes of about 30° reaching upwards from the valley, and above them terrace after terrace of harder bands that represent the castle like erosion. The slopes, as well as in many places the bluffs, are partially covered with pine trees (*Pinus murryana* Eng.). The trees on the slopes are stunted, gnarly and knotty, and are strongly marked by their great struggle for existence under the most unfavorable conditions. The oldest of these trees vary in diameter from eighteen inches to two feet, and have been recording the rate of erosion on these slopes for about 300 years.

Erosion has been so rapid that the oldest trees are now standing upon their stilt-like roots, with their trunks elevated from the slope some three or four feet. The rate of erosion appears to have been uniform with the growth of the trees. The trunk of the sapling remained on the ground; while the trunk of a tree six inches in diameter was often several inches above the surface, and the tree a foot in diameter was already upon stilts. On account of the shortness of our stay, absolute measurements of a large number of trees could not be made. Nor

could the exact age of a number of trees be determined. This has been planned for future work and will be executed at the earliest possible date. The fact, however, that these trees have acted as silent guards for centuries over these slopes and have recorded with unerring accuracy the rate of erosion is apparent, and as soon as the data can be secured, there will be a valuable factor for converting geological time into years.

By approximating the various estimates in connection with the date the following may be of interest: The Hole where the observations were made was about six miles wide. The trees were 300 years old and there had been on an average of three feet of rock removed from their roots. This would require one hundred years to remove a foot of the formation. Considering that the erosion started in the center of the Hole, there has been three miles removed from either side, which at the rate of one foot per century would require 1,584,000 years. Without question this erosion commenced at the close of the Miocene and hence represents the entire Pliocene and Pleistocene Epochs. The exact time relation of the Pliocene, and Pleistocene in relation to Eocene and Miocene has not been established; but if the Pliocene and Pleistocene Epochs represent 1,584,000 years it would not be out of the way to estimate Cenozoic time at 4,000,000 years. If this value be substituted in the ratios of geological time suggested by Dana:—Paleozoic: Mesozoic: Cenozoic as 12 : 3 : 1 then all geological time since the beginning of the Cambrian would be represented by 64,000,000 years. This estimate is not inconsistent with some already made; but when founded on absolute data may vary much from this. Nevertheless, whatever the results may be when found upon a complete investigation of this subject, they will furnish valuable scientific data that will aid materially in giving us a better understanding of geological time in terms of years.

WILBUR C. KNIGHT.

GEOLOGICAL LABORATORY
UNIVERSITY OF WYOMING,
October 2, 1899.

SCIENTIFIC BOOKS.

La géologie expérimentale. Par STANISLAS MEUNIER, Professeur de Géologie au Museum d'histoire naturelle de Paris. With 56 figures in the text. Paris, Ancienne librairie, Germer Baillière et cie. 1899. Pp. 311. (Bibliothèque Scientifique Internationale, XCII.). Price, 6 frs.

Just twenty years have elapsed since Daubrée brought out his famous work *Études synthétiques de géologie expérimentale,* and laid thereby the foundations of the school of French experimentalists. This book was translated into German in the following year, 1880, but never found an English interpreter. That such an edition was needed is shown by the reference in Dana's Manual of Geology to an alleged experiment of Daubrée with plates of *ice*, which should have been rendered plates of *glass*.

The mantle of Daubrée seems to have been taken up by M. Stanislas Meunier, who enjoys the distinction of having reduced the odds and ends of experiments, performed in the imitation and illustration of geologic processes, to a system of lectures for the entertainment and instruction of a large class of students. The present book is a *résumé* of these lectures as given in the year 1898 at the Museum of Natural History in Paris.

The scope of the work is general, in that the experiments described relate to a wide range of phenomena, *e. g.*, the formation of rainprints, stream channels, deltas, solution furrows, weathering, disintegration and decomposition of rocks, the striation of rocks, sedimentation under varied conditions, the production of faults, folds, and systems of fracture and displacement. The treatment of the subject, however, is somewhat narrowed by the fact that the author deals almost altogether with his own experiments, with only incidental reference to the work of others. The book cannot be said, therefore, to represent fairly or comprehen-

sively the state of experimental geology. The critical student to whom experiments are the last resort will find from footnotes that most of the author's tests are more completely described in the *Comptes rendus de l'Academie des Sciences*.

The grouping of the subject matter is good, experiments relating to epigene processes coming first and those pertaining to the theory of hypogene actions following. An introductory chapter of 34 pages is an apology for and defense of 'La Geologie experimentale,' a frank statement that the methods and its results are scorned in certain quarters. While this admission seems not inappropriate, the frequent references in the body of the work to the distinction between experimental geology and geology as ordinarily pursued, appear somewhat pathetic and out of place in a book designedly published in the interests of science and for the popularization of this subject. Notwithstanding the fact that many of the author's attempted explanations of natural phenomena would probably not be accepted by geologists, it cannot but be instructive to many who have not grasped the facts of the earth's structure to see how by some simple mechanical contrivance phenomena simulating mountains, the action of volcanoes, the effects of earthquakes and the like may be produced. However far removed the apparatus employed may be from the exact processes in nature, analogies described in the text must displace much misconception which prevails in the popular mind concerning the operations of the earth forces.

It is to be regretted that the author did not state the principles governing experimentation and something of the limitations of the method. Though the objections to certain experiments are briefly referred to, there is much which has been said on the subject of which we find no echo in this book. A text-book giving a comprehensive view of the subject with critical notes would be a welcome addition to our geological laboratories.

As for the experiments, many of them illustrate everyday changes which it is customary in all favorably situated colleges to demonstrate in the field where the natural process and its product may be seen under more favorable circumstances than in the laboratory. That experimentation without accurate knowledge of the facts to be explained is not infallible, is well illustrated by the different conclusions reached by Daubrée and Meunier in regard to the rectangular courses of rivers. Daubrée, it will be recalled, sought to explain the right-angled courses of streams by postulating preëxistent faults as guiding lines for the drainage. At the time he did his work this explanation had many adherents. It is manifestly no difficult matter for a clever artisan to devise a model in which the conditions of the hypothesis and the expected results are satisfactorily demonstrated. Professor Meunier, evidently familiar with the current view that such rectangular courses arise in the development of a river system upon certain geological structures unaffected by faults, performs an experiment through which he comes to disbelieve in Daubrée's conclusion. Incidentally the phenomena of the headwater gnawing of streams, the recession of falls, and river-capture, are artificially reproduced. It is to be noted that in the discussion the reference to 35,000 years as the time required for the recession of Niagara Falls indicates an oversight on the part of the author of all recent investigations on that subject.

Some of the experiments intended to illustrate the phenomena of meanders in streams seem hardly legitimate, or at least there is no endeavor to imitate nature in the employment of a stream of mercury and in the production of meanders on a slope of 20 degrees! The object of the experiment seems here to have been lost sight of! Likewise the agitation of a flexible cord, substituted for a stream with meanders, in the attempt to illustrate the control of the meander is amusing, but it may be questioned whether it is convincing.

Other experiments are described as designed to prove the competency of running water to excavate valleys and with the further purpose of combating the lingering notion in France that 'we are now in a period of geologic tranquility.'

Under the head of marine and lacustrine denudation, M. Stanislas Meunier treats of the mechanical action of waves and the chemical action of water. The experiments with wave

action are seemingly very incomplete in that no mention is made of the formation of shore-bars, spits, hooks, etc. It seems likely that the scalloped beaches described by Jefferson (*Journal of Geology*, Chicago, VII., 1899), might have light thrown on their origin by proper experimentation.

"Glacial geology offers an extended field for experiments, and in this connection our author proceeds to imitate the formation of crevasses, employing stearin placed on a band of rubber. Tension is applied and crevasses are formed. To demonstrate glacial erosion by the striation of rock fragments, the simple friction experiment of Daubrée and others is repeated. It should be said that this experiment does not offer a very close analogy to the conditions in a glacier on account of the 'plasticity' of ice. But it is in regard to recurrent occupation of a field by glaciers that M. Stanislas Meunier makes his most novel suggestion. His proposition may be given in nearly his own words:

"Given a glacier, and everything else remaining in equilibrium, it tends to diminish in spite of seasonable changes, by reason of the progressive lowering of its basin of supply [because] the materials which it transports in such great quantities along with the water which is associated with it, reduce the relief of the ground. It then recedes, and behind its abandoned frontal moraine vegetation is established. But, comparable at all points with rivers, it gnaws back progressively at its head, and it is possible for this recession to reach the point by destroying the rocky arête which separates its basin from that of a neighboring glacier, where it is permitted to divert this glacier to its own basin. Thereupon an increase of substance ought to provoke a return to the dimensions formerly held, and from that time the products of the fossilization of the plants established upon the first glacial terrane will be covered with a second morainal extension."

It is our author's view that this phenomenon of capture of glaciers by being reciprocal and recurrent, accounts for the so-called successive glacial periods in the Pleistocene. He necessarily attempts to refute the theory that these epochs of glaciation and deglaciation are 'general and simultaneous.' While the oscillations of glaciers in a region of valleys such as the Alps might very plausibly be affected by changes of this kind, it is not so apparent that the broad marginal oscillations of the ice-sheet of North America, for instance, can be explained in this manner.

We next find a brief chapter on the work of underground water. Several simple and readily devised means are adopted for imitating the leading features in the production of water-worn channels, tunnels and the striation of pebbles *en masse* through movements initiated by the washing out of supporting materials. The author indulges in some animadversions upon the nature of the scratched drift of the pre-alps of Europe and holds to the opinion that much of the so-called glacial drift of that region is really material striated in mud-flows—of which subject there is more to follow.

Eolian denudation is passed over with a few references to the geological work of the winds and to the well-known experiments of Thoulet. The term *abrasion* employed in a technical sense for wind erosion has not so extended a use among English-speaking writers as the author evidently thinks. Walther's term *deflation* is the only one apparently commanding anything like general use.

The processes of sedimentation receive a well-deserved attention. In this connection the author devotes several pages to the subject of mud-flows, a feature of many moist mountain regions which has been given evidently too little attention by geologists, but which is hardly so important a factor as the author intimates. There are a number of experiments described to show the rate of falling particles in water; and small points bearing on the criteria of horizontality in the deposition of certain strata are brought out. None of these precautions, however, appear to have escaped the attention of field geologists and the author here, as elsewhere, seems to have been forestalled in many of his discoveries. The statement that floating trees in large rivers sink root downward and thus may be buried upright giving the appearance of buried forests appears to pertain to observational geology. There are experiments to show the amount of water included in sediments. A frequent defect of the book is the

mere reference to experiments which are not described, as, for instance, in the case of deltas. The deposition of sediments in the subterrane is treated experimentally and chemical alterations inducing color bands are imitated.

M. Stanislas Meunier has successfully reproduced fossil footprints by blowing sand upon the tracked surface covered with a slight depth of water. He conceives, therefore, that fossil footprints cannot have been preserved by the rise of water spreading sand over the surface on which tracks were made. It remains for some clever manipulator to prove the converse of this proposition as equally effective. The author's point is a good one, however, and the numerous instances in the older strata in which mud-tracked surfaces are covered with sand is a strong argument in favor of his theory.

Dessication of strata and their torsion are next taken up. The author concludes from his experiments that regular rhomboidal jointing is not to be explained by torsion as Daubrée labored to prove. Neither Daubrée nor the author have imitated with any degree of accuracy the conditions in which the stratum is placed when it yields to the jointing strain, and critical experiments are much needed in the elucidation of an old but not yet satisfactorily solved problem.

A very brief reference to the origin of the crystalline rocks deals mainly with the work of Messrs. Fouqué and Lévy on the igneous rocks. An even shorter discussion of metamorphism touches only some of the concomitants of metamorphism, such as the carbonization of wood tissue. The experiments of Sénarmont and a few others are referred to in the explanation of metalliferous veins, and a few words are given on the subject of kaolinization and serpentinization.

Our author now plunges boldly into experiments designed to elucidate the origin of the primitive crust of the globe. He assumes that beneath the *débris* of the surface there exists a granitic zone, under which occurs a shell of which silica, magnesia and iron constitute the greater part, citing, as evidence of this latter rock, dunite, and the dolerite with native iron at Ovifak. This shell is supposed to have been formed by a precipitation from the nebular gas. The author has obtained in a porcelain tube the synthesis of the principal silicates of magnesia without the intervention of fusion in illustration of this conception. He concludes from his experiments that the solid shell of the globe which was first formed and which had analogies with the solar photosphere, consists of magnesium silicate rocks with an abundance of metallic concretions of which the genesis is related to the phenomena still evident in the material of tin-bearing veins and even in the chimneys of volcanoes. There results, he goes on to state, a relative distribution, in which the consideration of the density of the bodies studied at ordinary temperatures plays no part. Metallic iron, for instance, no "longer appears as constituting a massive nucleus, but on the contrary as forming a true shell below which have been congealed in later times the rocks of which eruptions have procured for us specimens in every geologic epoch."

In part second of this book over 50 pages are devoted to the application of the experimental method to the problems of deep-seated mechanical action. The remarks on the effects of weight or gravity appear not to be suggested by experiments, but to have risen out of the general philosophy of geology. Indented pebbles are ascribed to pure pressure without chemical solution.

An experiment is described with the design of showing the supposed effects of the centrifugal force upon the original crust of the earth. The substances employed in a rotating glass bottle of spherical shape arrange themselves about the equator in the inverse order of their densities contrary to what would be expected from gravity alone. This experiment is largely relied upon for some of the conclusions previously stated regarding the nucleus of the earth.

An experiment to illustrate the formation of volcanic cones reproduces such little burst steam bubbles as one sees in the paint-pots of the Yellowstone Park. Laccoliths are also, it is stated, reproducible by means of melted wax injected between sheets of plaster having a slight degree of plasticity.

Professor Meunier attempts also the famous problem of introducing water into the interior

of the earth, in short, into his infra-granite zone. He holds that the water which comes out in volcanoes cannot be original, because the temperature of the globe is constantly decreasing and that past conditions were still less favorable than the present ones for the maintenance of water in the interior. He thinks, therefore, that the water is of recent introduction.

"The solution of the question," states our author, "appears to result from some very simple experiments of M. Stanislas Meunier." Without describing the experiment which in no way duplicates the condition of the earth's crust at a depth, the author supposes that the water is brought into the infra-granitic zone as water of consolidation and crystallization embodied in fragments of rock which fall down along fault-planes and zones of crushing. The 'falling' of these hydrated rocks into the heated regions of the globe is supposed to give rise to volcanic explosions and as is stated in the next chapter to earthquakes also. The author very frankly states that he is obliged to note the profound astonishment which the first publication of his views elicited.

In the experiments on folds some interesting points are dwelt upon concerning the intersection of planes of fracture which arise, but these artificial faults are not compared with those of any particular region. Under the head of schistosity are described experiments which appear in reality to have induced a kind of cleavage as that term is understood in English. Fractures are produced by compression in some experiments which lead the author to reject Daubrée's famous radiating fractures produced by torsion, seemingly on the ground that such fractures have 'not anywhere been observed.'

The general distribution of mountains upon the globe last of all comes in for experimentation in the clever methods of the author. A small hemispherical shell has stretched over it a rubber layer coated with plaster, in such a manner that when the foundation, which represents the contracting nucleus of the globe, is allowed to retreat, the contraction of the rubber layer induces compression of the plaster. This stress is relieved by circumpolar lines of shearing and displacement, the overthrust being poleward in direction. The author points out the analogies which seem to exist between this model and the arrangement and orogenic movements of the mountain systems of Europe. The researches of Suess on the northwesterly movement of the Eurasian thrusts should be noted as favoring this hypothesis, but it is difficult to see in what way the view is exemplified on the North American continent.

The book is closed with a 'Postface' or statement, with which most geologists will probably agree, that this volume sets forth facts amply sufficing to justify the *raison d'être* of experimental geology. Whatever misgivings one may entertain concerning the decisive character of some of the experiments, there can be no doubt of the suggestiveness of the original and ingenious methods which the author has brought to bear upon some of the largest questions of dynamical geology. The book is illustrated with a few good cuts and is well printed. A list of contents takes the place of a good index. The publishers have taken the liberty of appending 35 pages of advertising matter which might have been omitted.

J. B. W.

Leçons sur la détermination des orbites professées à la Faculté des Sciences de Paris. Par F. TISSERAND; redigées et développées pour les calculs numériques par J. PERCHOT; avec une préface de H. POINCARÉ. Paris, Gauthier-Villars. 1899. 4to. Pp. xiv + 124.

These lectures formed a part of the course in mathematical astronomy delivered at the Sorbonne by the late Professor Tisserand, but the important question of the determination of cometary and planetary orbits was not treated in his well-known treatise on celestial mechanics. The only work in the French language devoted to the numerical elements of orbits is the translation of Oppolzer's treatise, which is a most useful book to the computer, but neither easy nor attractive to the reader; on the contrary the lectures of Tisserand exhibit the clearness of exposition and the simplicity and elegance of method which uniformly characterize his writings, so that all devotees of mathematical science will be indebted to M. Perchot for this edition of the unedited lectures of his lamented master. Professor Poincaré's pre-

face, the most interesting chapter of the volume, is a graceful memorial to his predecessor at the Sorbonne; it discusses the methods of Laplace, Gauss and Olbers, together with other possibilities in the determination of orbits, and concludes with a concise *résumé* of the method followed in Tisserand's exposition.

In the first chapter Tisserand presents the method of Olbers for the determination of parabolic orbits. By this method the calculations fall into two parts: 1°. No hypothesis is made as to the nature of the orbit, and the six equations are combined in such a manner as to yield a unique equation; this combination can be made in an infinite number of ways and thus yield an infinite number of equations; Olbers effected it in such a happy manner that the unique equation assumes a remarkably simple form whose simplicity is conserved in the second approximation if the observations are equidistant. 2°. In the second part the condition for a parabolic orbit is introduced, thus reducing the number of unknowns to five: to the four equations given by the two extreme observations is joined the unique equation obtained in the first part. Four equations in four unknowns are to be solved; resort must be had to successive approximation. The chief advantage of Olber's method is that the only equations which present difficulties of computation contain only two unknowns; tables of single entry give one of these as functions of the other.

The second chapter presents the well-known method of Gauss for the determination of the orbit of a planet from three observations elaborated in his *Theoria motus*.

M. Perchot has increased the usefulness and convenience of the book by appending general *résumés* of the formulæ in definitive form for computing together with the numerical calculation of the orbit of the asteroid, 1897, DJ., in which no detail has been omitted; this model computation and reproductions of Oppolzer's tables VIII. and IX. conclude the work.

E. O. LOVETT.

Lexikon der Kohlenstoff-Verbindungen. Von M. M. RICHTER. Zweite Auflage der "Tabellen der Kohlenstoff-Verbindungen nach deren empirischer Zusammensetzung geordnet." Hamburg und Leipzig, Verlag von Leopold Voss. 1869.

The work bearing the above title is another product of the indefatigable energy and painstaking care of a German chemist. In 1883 Dr. Richter gave out his 'Tabellen der Kohlenstoff-Verbindungen' arranged in accordance with empirical formulas. While that edition contained 16,000 compounds, and the third edition of Beilstein now reaching completion has some 57,000 compounds described within its spacious pages, this dictionary says something about 67,000.

The work is conveniently divided into the following parts: Introduction, System and Nomenclature; List of about 67,000 compounds and their percentage composition; Register of Proper Names; Table of Numbers for finding the Percentage Composition.

The dictionary is to be issued in about thirty-five numbers, the first eleven of which are at present in hand. Each number contains sixty-five pages and is of the same size, style and print as the *Lieferungen* of Beilstein's 'Organische Chemie,' 3 Auflage.

In the Preface, which, with the Introduction to the system and nomenclature, is given in four languages (German, English, French and Italian), Dr. Richter states that the work was begun ten years ago. Three causes are ascribed for the length of time required to complete the work: viz., changes of nomenclature at the Geneva Convention, the immense number of new facts made known in the time and his own business engagements. Professor Beilstein's desire to exhibit the percentage composition of additional types CHO, CHN, and CHON, thereby adding some 20,000 formulas, has been complied with.

The alphabet of the system shown in the succession of the elements combined with carbon, as determined by the frequency of their occurrence is as follows:

(1) H, O, N; Cl, Br, I, F; S, P.

(2) All the other elements are placed in alphabetical order: A–Z.

The elements follow each other in horizontal and vertical rows according to the number of atoms.

C H O N Cl Br I F S P Al As . . . Zr.
O
N
Cl
Br
I
F
S
P
Al
As
.
.
.
Zr.

The arrangement is really automatic, but there are some explanations given in the Introduction by which an empirical formula may be deduced from the Index of names which accompanies the tables. The lexicon is a collective index to Beilstein for all the compounds therein treated, reference to volume and page being given. Some 8,000 more are also given. These compounds will probably be treated in supplements to Beilstein. Polymeric compounds with fixed molecular weights are registered under their own formulas; $(CHON)_3$, cyanuric acid is found under $C_3H_3O_3N_3$. Reference to purely theoretical papers are omitted, as well as those dealing with analytical, physical, mathematical, crystallographic and medico-physiological data. Papers which describe methods of preparation and properties of the substances and the immediate changes they undergo only are referred to. The immense amount of material has, of course, necessarily been much condensed, authors' names being omitted and abbreviations of journals used. Further, words of frequent occurrence have been abbreviated by using the German abbreviations. This is all explained, however, by a table giving the meanings of the abridgments in the four languages named above.

The author not only recommends that writers in future give the empirical formulas, but also adopt the arrangement of formulas as given in his book. This attempt at uniformity in the writing of formulas has already been inaugurated by the German Chemical Society in the *Berichte* beginning with 1898. An illustrative example may be given; we usually write $C_6H_5NO_2$ (nitro-benzene); by following the order given above this should be $C_6H_5O_2N$. For the sake of classification this is a great convenience and should be insisted upon in the American and English journals, for the immense amount of new material annually added to our already gross number of organic compounds must have systematic arrangement for many obvious reasons. It is by no means desirable, however, that this take the place of the rational formulas, but be given in addition. To economize space, structural formulas are omitted from the volume, but some ten pages are given to the graphic illustration and naming of the ring-systems containing O, S, Se, N, P.

In order to secure a satisfactory nomenclature the 'principle of substitution' was adopted. For example:

"(1) Every compound with fixed constitution is referred to the group-substance from which it is derived, namely, to the hydrocarbon or to the corresponding cyclic system which contains the smallest number of hydrogen atoms, as benzene, naphthalene, pyrrol, etc.

"(2) This group-substance remains intact in naming the derivatives and must always figure as such in the names of the derivatives, no alterations taking place, as pyrazole into pyrazoline, etc.

"(3) Hydrogenized group-substances are named di-, tetra-, etc., hydroderivatives, as dihydropyrazole for pyrazoline.

"(4) Group-substances are named, (*a*) hydrocarbons of aliphatic series in accordance with the resolutions of the Geneva convention; (*b*) for Aromatic hydrocarbons present used terms as benzene, indene, naphthalene, anthracene; (*c*) Ring systems containing O, S, Se, N, P as named in the ten pages adverted.

"(5) As the formation of the derivatives of group-substances may be regarded as taking place by the substitution of hydrogen by other atoms or groups, so are the names derived from the group-substances.

Exception, and wisely, is taken to the Geneva nomenclature convention in indicating the position of the substituent in the open-chain series by letters from the Greek alphabet. In ring-compounds, as is usual, the location is indicated by numbers. The matter is up-to-date.

The entire work is a most valuable contribution to the reference books on Organic Chemistry and no laboratory can well afford to be without a copy. CHAS. BASKERVILLE.

UNIVERSITY OF NORTH CAROLINA,
September 30, 1899.

The Rise and Development of the Liquefaction of Gases. By WILLETT L. HARDIN, PH.D. Macmillans, 1899. 8vo. 250 pp.

Written from a historical point of view and with an ample command of the subject, this book of Dr. Hardin's is really a very satisfactory compilation. It is prepared with evident care and industry, and is finely illustrated. Why a 'popular-science style,' in which it professes to be written, should differ at times from good English, is not plain to the reviewer: but this is the severest criticism that need be made.

The author limits himself to a record of the statements of others, and he is therefore responsible chiefly for the selection and arrangement of his material. Here we might wish that the researches upon the more readily condensable gases, preceding the achievements of Cailletet and Pictet, had been treated more concisely, in order that more room had been found, toward the end of the book, for the discussion of the utilization of liquid air, etc., as at present proposed. The treatment of the latter topic is very scanty, in view of the fact that probably four out of five of the prospective purchasers of the book are interested in the uses of liquefied gases, rather than in the methods of their production. Two chapters, involving thermodynamics, would seem forbidding to the nontechnical reader, while they bring no new information to the chemist or physicist. If they could be made the basis of a new chapter, discussing the economic value of gas-liquefaction, for commercial refrigeration and for the intensification of the potential energy of engines, they would serve a most useful purpose.

MORRIS LOEB.

BOOKS RECEIVED.

The Compendious Manual of Qualitative Chemical Analysis. C. W. ELIOT and F. H. STORER. Newly revised by W. B. LINDSAY and F. H. STORER. New York, D. Van Nostrand Company. 1899. Pp. vii + 202. $1.25.

The Evolution of General Ideas. TH. RIBOT. Translated by FRANCES A. WELBY. Chicago, Open Court Publishing Company. 1899. Pp. xi + 231. $1.25.

Wabeno, the Magician. MABEL OSGOOD WRIGHT. New York and London, The Macmillan Company. 1899. Pp. xi + 346. $1.50.

SOCIETIES AND ACADEMIES.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of the Academy of Science at St. Louis, held on the evening of October 16th, a paper by Dr. T. J. J. See, on the temperature of the sun and the relative ages of the stars and nebulæ, was presented in abstract by Professor Nipher.

The author reviews the work of Helmholtz on the condensation of a homogeneous sun and finds that the heat developed in gravitational condensation from an infinite volume to its present size would be sufficient to heat an equal mass of water about 27 million degrees. In condensing to a mass whose radius was equal to the radius of Neptune's orbit, only about 1 / 6600 part was produced as has been produced since. Nearly all of the heat has been developed since the primitive nebula has reached the dimensions of the solar system. The heat developed before the nebula came within the orbit of Mercury, is only about 1 / 85 part of the total heat produced up to the present time. If the sun should contract 1 / 10000 part of its present radius, 69,700 M., assuming it to be homogeneous, the heat would raise the temperature of an equal mass of water 2,725 degrees. The effect of the various planets is considered, and is shown to be insignificant. An annual shrinkage of 35 meters a year would account for the present heat and would effect the radius less than 1 / 10″ in 1,000 years. The fact that ancient and modern eclipses are sensibly of the same duration, in connection with the substantial constancy of the moon's mean distance, shows that no considerable alteration of the sun's diameter has occurred in historical time. The essential constancy of solar radiation during the last 2,000 years is well established by the agreement of plant distribution now with that described by Pliny and Theophrastus.

Dr. See then takes up the case of a hetero-

geneous sphere made up of layers of uniform density, but increasing in density towards the center.

The radiation as at present determined is assumed to apply to all time past and present, and the density is assumed to vary from center to circumference, in accordance with Lane's deductions in 1870, the value of K, the ratio of the two specific heats being 1.4.

Lane found the density at the center to be 23 times that of water, and by a different process, Kelvin has found it to be 32 times that of water.

Assuming a surface temperature of 8,000 degrees, as found experimentally by Wilson and Gray, the temperature at the center comes out 256,000 degrees C.

The potential of the heterogeneous sun thus assumed is then found by mechanical integration, by dividing the radius into 40 parts, the density of each shell being constant.

The energy developed by the falling together of the parts of this heterogeneous sun is greater than for the homogeneous sun of Helmholtz in the ratio of 176 to 100. As in the past history of the Helmholtz sun, the radiation would have dissipated this heat at the present rate of radiation in 18 million years, it follows that if the Helmholtz sun should pass into the heterogeneous sun, discussed by See, by inward gravitation of particles, the past history is increased by about 14 million years. This augmentation of its past is at the expense of its future duration.

The author gives reasons for thinking that condensation cannot go on unchecked by molecular forces after the radius has shortened to much over one-half its present length, and assigns 36 million years as a fair value for the total life of the sun from the time its radius was that of Neptune's orbit to the time when its radiation will become insignificant. Of this total period 32 million years, or 8/9 of the whole, have already elapsed, leaving four million years for a fair estimate of its future duration, with the conditions assumed.

There is reason to believe that under the immense temperatures existing in the sun, the gaseous mass may be so dissociated that all gases behave like monatomic gases. This would increase the ratio of specific heat at constant pressure to that of constant volume from 1.4 to 1.66. This changes the law of density and temperature along the radius. The density at the center becomes much less and the potential of the whole mass upon itself is correspondingly less exhausted. It increases the probable future life of the sun from four to 13 millions of years, and diminishes its past history from 32 to 23 million years. The author concludes that life as it now exists on the earth cannot be maintained longer than three million years, and after five or ten million years, the planet will have become a rigid and lifeless mass.

Dr. H. von Schrenk presented some notes on *Arceuthobium pusillum* which was found in Maine, during the past summer, growing on the white spruce along the sea-coast. The trees which are attacked form large witches' brooms, the branches of which are much longer than the normal branches. The manner in which the seeds are distributed was briefly described, and seeds were exhibited adhering to branches of the white spruce.

WILLIAM TRELEASE,
Recording Secretary.

WASHINGTON CHEMICAL SOCIETY.

THE regular meeting was held May 11, 1899.

The first paper of the evening was read by Professor F. W. Clarke and was entitled: 'Experiments on the Constitution of Certain Silicates,' by F. W. Clarke and George Steiger.

The paper cited some results obtained by Clarke and Schneider in 1889–92. The present work led to the following conclusions:

1. That pectolite is a metasilicate.
2. That the formula for pyrophyllite is possibly that of a basic di-metasilicate.
3. That calamine is probably a basic metasilicate which is in accord with the accepted formula.

With analcite a very interesting ammonia compound was formed, by heating with ammonium chloride. Other experiments agreed closely with those made by Friedel and it was concluded that this mineral is a mixture of ortho- and tri-silicates.

The last paper of the evening was ready by Dr. H. N. Stokes and was entitled: 'Indexing Organic Compounds.'

Mr. Chesnut exhibited utensils used by the Indian women in the preparation of acorn meal.

WILLIAM H. KRUG, *Secretary*.

ASTRONOMICAL NOTES.

CLOCK RATES AND BAROMETRIC PRESSURE.

ENSIGN EVERETT HAYDEN, U. S. Navy, publishes in the Publications of the Astronomical Society of the Pacific, No. 68, an interesting investigation of the effect of variations in barometric pressure upon the rates of clocks and chronometers. This study was made at the Mare Island Observatory, where chronometers are rated for the U. S. Navy, and where the time observations are regularly made, which are supplied by the Western Union Telegraph Company to that part of the country west of Ogden, Utah. The paper gives in detail the results for the Mean Time Clock of the observatory and for three Negus chronometers. The method is empirical, depending upon the rates actually observed under varying pressure and temperature, and the numerical results are obtained graphically. From tests of the Mean Time Clock extending through two hundred days, it is believed that had the rate-curves been used without any time observations the errors of the noon signal would at no time have exceeded six-tenths of a second, and seldom have exceeded one-tenth of a second, and at the end of the period would have been correct within a few hundredths of a second. The barometric and temperature curves of the sidereal and mean time clocks are now used in the current work of the observatory, and the author is of the opinion that a first rate pendulum clock is a much better instrument than usually supposed, and actually comparable in uniformity with the axial rotation of the earth, if account is taken of these variations. The experiments on chronometers lead the author to believe that the use of a barometric curve in actual practice at sea is worthy of trial, and the navigator of one of our naval vessels now in the Pacific will report upon his experience with the three chronometers whose rates are discussed in the paper.

STELLAR PARALLAX BY PHOTOGRAPHY.

A CONTRIBUTION to this subject is made by Östen Bergstrand of the observatory at Upsala. The author discusses the theory of the reduction of measures on the photographic plates and the instrumental errors of the Repsold apparatus employed. The parallax of $\Sigma 1516\, A$ is found to be $0.''080 \pm 0.''011$ and of $A-Oe.$ 11677, which has a proper motion of nearly $3''$, to be $0.''192 \pm 0.''013$. These determinations were made on account of the discrepancies in the results of other observers. The paper is in Swedish but an abstract in French is supplied.

JUPITER'S FIFTH SATELLITE.

PROFESSOR BARNARD has added to our knowledge of the period of this satellite the results of his observations in the last two oppositions of Jupiter made with the 40-inch equatorial of of the Yerkes Observatory. Combining these with the earlier observations at the Lick Observatory, the period is 11 h. 57 min. 22.647 sec. and is not in error exceeding 0.01 sec. The discordancies in the separate determinations are very small and the measures show the great accuracy attainable in micrometric observations with these large refractors upon difficult objects.

WINSLOW UPTON.

PROVIDENCE, R. I., Oct. 14, 1899.

CURRENT NOTES ON METEOROLOGY.

KITE AND BALLOON METEOROLOGY IN FRANCE.

Two communications have been made to the French Academy of Sciences during the past summer by Teisserenc de Bort on the kite and balloon work carried on at the Observatory of Trappes. Altitudes of 3,940, 3,590 and 3,300 meters were reached on June 14th, June 15th, and July 3d, respectively. The results obtained by means of the kite meteorographs during more than 100 ascents show that in anti-cyclones the rate of decrease of temperature aloft becomes slower at a distance of a few hundred meters above the ground, and inversions of temperature are often observed. In cyclonic areas the decrease of temperature is more rapid. In fine weather, with high pressure, the wind velocity generally decreases with increasing distance from the ground up to an altitude between 1,500 and 3,000 meters. On the other hand, on cloudy days, with low pressure, the velocity

increases with altitude, especially near the lower cloud stratum. (Paper read, July 10th.)

Some of the results obtained during more than 100 ascents of *ballons-sondes*, 7 of which ascents were higher than 14,000 meters, 24 higher than 13,000 meters, and 53 of which reached 9,000 meters, were discussed by de Bort in a paper read before the Academy on August 21st, last. The most important conclusions reached are as follows: I. The temperature at different altitudes shows notable variations during the course of the year, which are much greater than was supposed as the result of the older observations made in balloons. II. It appears that there is a fairly well-marked tendency to an annual variation of temperature as high up as 10,000 meters, the maximum being reached towards the end of summer, and the minimum at the end of the winter. This phenomenon is much complicated by the marked variations from day to day, which are related to the conditions of atmospheric pressure.

CENTIGRADE *versus* FAHRENHEIT SCALE.

The discussion as to the relative merits of Centigrade and Fahrenheit scales has lately come up again in connection with the use of these scales in meteorological work. In *Nature* for August 17th, Buchanan points out that the zero on the Centigrade scale occurs at such a place as to make nearly half of the readings come below zero. Hence the scale must be read upward half the time and downward half the time, which is awkward. Furthermore, the averaging of the results is extremely troublesome, and mistakes are easily made. Clayton (*Nature*, Sept. 17th), agrees with the opinion expressed by Buchanan, and makes the novel and ingenious suggestion that if the Centigrade thermometer is ever adopted for meteorological purposes by the English-speaking nations, the freezing point of water should be marked 273° on the scale and the boiling point 373°. By this method meteorologists would have at once the temperatures concerned in the change of volume of gases, and embodied in many formulæ, and the difficulty of the inverted scale, above referred to, would be eliminated.

R. DeC. Ward.

Harvard University.

NOTES ON INORGANIC CHEMISTRY.

A paper on Solid Hydrogen was read by Professor Dewar at the Dover meeting of the British Association and is reprinted in the *Chemical News*. It is only since the fall of 1898 when it has been possible to obtain liquid hydrogen in quantities of one or two hundred cubic centimeters, that attempts could be made to solidify it. The principle used was that of a vacuum tube containing liquid hydrogen immersed in a bath of liquid hydrogen contained in an outer vacuum tube connected with an air pump. When the pressure in the outer tube is reduced below 60 mm., the hydrogen suddenly solidifies into a white froth-like mass like frozen foam. In the inner tube the upper part of the solid hydrogen is frothy, but below it is a clear solid resembling ice. The solid melts at a pressure of 55 mm., or under a pressure of 35 mm. at 16° absolute (—257° C.). The boiling point of liquid hydrogen at 760 mm. pressure is 21° absolute (—252° C.). The foamy structure of the solid hydrogen is doubtless due to the fact that rapid ebullition is substantially taking place throughout the entire liquid, owing to its extreme lightness, for the specific gravity of liquid hydrogen is only 0.07 at its boiling point, and its maximum density not over 0.086. The lowest temperature now obtainable is from 14° to 15° absolute (—259° to — 258° C.), reached by the evaporation of solid hydrogen in a vacuum.

A new method of separating the active constituents of racemic compounds is described by Marckwald and McKenzie in the last *Berichte* of the German Chemical Society. It is based upon the fact that while isomeric acids of the fatty series have nearly the same affinity, and the same limit of ester formation, the speed of the latter depends very markedly upon the structure of the acid molecule. In the described experiment racemic mandelic acid and menthol were heated together for an hour—menthyl mandelic ester was formed and that portion of the mandelic acid which was unacted upon was recovered and found to be lævo-rotary; the dextro-rotary acid was thus changed to the ester first. While perhaps of no practical application, this method is of theoretical interest, as it adds a purely chemical method of

splitting racemic compounds, to the three already known, the mechanical, the bio-chemical and the physical.

J. L. H.

LIMITATIONS OF THERMODYNAMICS.

AN important paper has recently been issued from the press of Dunod as a reprint from the *Revue de Mécanique*, current volume, in which M. Georges Duchesne presents the results of a very extensive experimental study of the thermal and thermodynamic processes in operation in the steam engine and especially during the period of emission, which has been the most difficult of investigation and the most obscure of all the elements of the vapor-engine cycle.*

With a vapor engine in steady operation the observation of the amount of liquid passing through the system in the unit of time gives the measure of the quantity taken into the working cylinder at each stroke of its piston, and this, with the determination of 'quality' by the 'calorimeter,' and automatic registration of volumes and pressures, by the 'indicator' of Watt, permits the exact apportionment of energies and the physical condition of the fluid to be determined from the instant of closure of the induction-valve to its opening at the commencement of exhaust. The delineation of the 'saturation-curve' on the indicator-diagram, for the quantity of fluid known to have entered the cylinder, gives the measure of contemporaneous volumes of the corresponding quantity of 'dry and saturated' vapor which serves as the unit of the scale measurements of the relative volumes, and weights of liquid and vapor in the mixture constituting the working fluid, or the extent of superheating, if at any point superheated. From the instant of commencement of emission, however, no measure is obtainable of these quantities, and the problem becomes incapable of solution by ordinary observation.

Donkin has sought the solution of this particular question of the state of the vapor in the period of emission and that of compression by the use of his 'revealer,' by means of which the fluid is sampled and tested as to quality, and Professor Carpenter, in the laboratories of Sibley College, has sought the same end by the use of the now familiar 'steam-calorimeter,' taking off samples of the steam automatically at certain points in the portion of the cycle to be investigated. Donkin concluded that the vapor in the exhaust period was wet; Hirn, Carpenter and others, including Dwelshauvers-Dery, have found it dry. M. Duchesne revises the work of Donkin, particularly, and concludes that, contrary to the deduction of the investigator himself, the research indicates that the vapor is dry and saturated during the period of emission. He decides that the results of those experiments furnish 'proof of the complete dryness of the surface at the end of emission.' If dry at this point, they will presumably continue dry up to the beginning of the period of compression, and, then, mechanical compressions alone affecting the fluid, superheating should occur. This was the conclusion of the writer long before the apparatus and method of recent research was ready to give its testimony in the case,* as respects economically operated engines; but the contrary as regards uneconomical engines, in which the working fluid, after entering the cylinder, is very wet, and Willans based upon the same conviction the details of design in his engine insuring that the moisture deposited upon the cylinder-walls should be swept off as thoroughly as possible by the current of the working fluid. M. Duchesne finds confirmation of these anticipations in the work of Hirn, of Delafond and of Dwelshauvers-Dery; the latter affording him very conclusive evidence, which he reviews at length.

The conclusions reached are the following, in substance:

(1) When, in the engine-cylinder, the vapor is saturated and the walls humid, the vapor and the water on the surface of the metal in immediate contact with the liquid assume almost instantaneously the same temperature.

(2) If the surface is dry, it may take a temperature superior to that of the fluid.

* L'état de la Vapeur a la Fin de l'Émission; par Georges Duchesne, Ingénieur, ancien Assistant du Professeur V. Dwelshauvers-Déry; Paris, Vve. Ch. Dunod, 1899. Royal 8vo., pp. 15.

* Manual of the Steam-Engine, Vol. I., § 53, pp. 355–627, especially p. 631. Trans. A. S. M. E., 1890, No. CCCLXII.; 1894, No. DLXVI.; 1894, 1896, pp. 843, etc.

It is to be remembered that the nearer the fluid to the state of saturation, the more readily does it surrender heat.

In the indicator-diagram it is often observed that there exists a point of inflexion at the summit of the compression-curve. This has been, by earlier authorities, generally ascribed to leakage past the piston on attaining a certain limiting pressure at which the piston-rings yield. Later observers have suspected and the writer has long believed that this peculiar inflexion may mark a point at which the surrender of heat of compression to the metal of the cylinder-wall occurs so rapidly, as a consequence of the increasing temperature-head, as to cause more rapid condensation than can be counteracted in its effect upon pressure by the constantly diminishing rate of compression. This phenomenon, in such case, is an indication, if not a measure, of the heat-exchange thus taking place. M. Duchesne finds confirmation in his own experiments of this later idea, and of the propositions which he has advanced, as well as of the accuracy of the work of M. Dwelshauvers-Dery.

R. H. THURSTON.

CORNELL UNIVERSITY.

SCIENTIFIC NOTES AND NEWS.

THE National Academy of Sciences will hold its annual fall meeting at Columbia University, New York, from November 14th to 17th.

PROFESSOR DEAN C. WORCESTER, of the University of Michigan, has returned to the United States, to report to the President as one of the members of the Philippine Commission.

PROFESSOR GEORGE T. LADD, of Yale University, who is at present in Japan, has received from the Japanese Emperor, the third-class decoration of the Order of the Rising Sun.

DR. EUGENE A. DARLING has been appointed bacteriologist of the Cambridge Board of Health, to succeed Dr. George B. Henshaw.

MR. W. H. TWELVETREES, F.G.S., has recently been appointed to the position of geologist to the Government of Tasmania.

DR. ALFRED JENTZSCH, docent at Königsberg, has been appointed geologist of the Government Survey in Berlin.

DR. OTTO LUBARSCH, associate professor at Rostock, has been made director of the pathological and anatomical division of the newly established State Institute of Hygiene at Posen.

MR. J. E. DUERDIN, curator of the Kingston Museum, Jamaica, is this year studying at the Johns Hopkins University.

MR. W. H. M. CHRISTIE, C.B., the Astronomer Royal has been elected one of the Wardens of the Clockmakers' Company.

DR. LOUIS L. SEAMAN offers, through the Military Service Institution of the United States, a prize of $100 for the best essay on 'The Ideal Ration for an Army in the Tropics.' Papers should be received before March 1, 1900.

MR. HAMILTON Y. CASTNER, died at Saranac Lake, N. Y., on October 10th, aged 41 years. Mr. Castner made important advances in industrial chemistry, especially in the manufacture of aluminium and in the electrolytic processes of manufacturing caustic soda and chlorine from cloride of sodium.

THE death is announced at Obersdorf of Dr. Ernst Rosenberger, known for his writings on the history of physics.

DR. KARL RUSS, the ornithologist, died at Berlin on September 29th, aged 66 years.

IT has been proposed to place a bust and an enlarged photograph of the late Dr. Friedel in the hall of the Sorbonne. The estimated cost of the bust, which will be the work of M. Uitain, is 3,000 francs. An appeal for subscriptions has been issued. These should be sent to M. Chason, at the Laboratory of Organic Chemistry, Faculty of Science, the Sorbonne.

AT the ceremonies attending the unveiling of the monument of Johannes Müller at his birthplace, Coblentz, on October 2d, Professor Virchow was the principal speaker. The British *Medical Journal* states that in the course of his address Professor Virchow referred to the difficulty that had been found in choosing an appropriate inscription. The simple one chosen by the sculptor: 'To the great anatomist and physiologist,' would perhaps hardly satisfy all concerned. Strictly speaking, Johannes Müller was a biologist, a naturalist whose aim

was the study of life itself in its universality. He was the first to use the microscope in researches on living beings; he was the first to disclose to us the fauna of the seas. His example inspired the deep-sea researches of our own day, of which the German scientific station in Naples formed a center. Professor Koester, Rector of Bonn University, speaking as the representative of the Monument Committee, handed over its charge to the mayor and municipality of Coblentz. Professor Waldeyer, Rector of the Berlin University, made the closing speech as the delegate both of the Berlin University, where Müller's chief teaching years were spent, and of the Prussian Academy of Sciences. In these two institutions, said Waldeyer, Johannes Müller had raised a monument to himself that no time could destroy.

THE Seventeenth Congress of the American Ornithologists' Union will convene in Philadelphia, at the Academy of Natural Sciences, 19th and Race Sts. (Logan Square), on Monday, November 13th, at 8 o'clock p. m. The evening session will be for the election of officers and members and the transaction of other routine business. The meetings open to the public, and devoted to the reading and discussion of scientific papers, will be held in the Lecture Hall of the Academy, beginning Tuesday, November 14th at 11 a. m., and continuing for three days. Information regarding the Congress can be had by addressing the Secretary, Mr. John H. Sage, Portland, Conn.

A TELEGRAM has been received at the Harvard College Observatory from Professor J. E. Keeler, at Lick Observatory, stating that the following elements and ephemeris of Comet *e*, 1899, were computed by Perrine from observations on October 1, 7, 16:

Time of passing perihelion	$=T=$	Sept. 15.04 G. M. T.
Perihelion minus node	$=\omega=$	10° 52′
Longitude of node	$=N=$	272° 13′
Declination	$=i=$	76° 55′
Perihelion distance	$=q=$	1.7854

EPHEMERIS.

1899. Oct. 24,	R.A. $17^h\ 5^m\ 8^s$.	Dec. +2° 17.′	Light 0.72
" " 28,	" 17 11 12.	" +3 21.	
" Nov. 1,	" 17 17 24.	" +4 25.	
" " 5,	" 17 23 36.	" +5 29.	" 0.63

THE American Museum of Natural History, New York, will hereafter be opened free to visitors on Wednesdays, Thursdays, Fridays and Saturdays, on Sunday afternoons and on Tuesday and Saturday evenings. The free lectures given under the auspices of the Board of Education are on Tuesday evenings and the lectures by Professor A. S. Bickmore to teachers in the public schools are on Saturday mornings.

THE London correspondent of the New York *Evening Post* states that two expeditions will soon take the field in South America. Professor Zittel, of Munich, is arranging to send a scientific expedition to Patagonia, and it is very probable that a similar undertaking will be organized in London on very comprehensive lines, the Argentine Government having promised to render aid and grant all facilities to a British expedition under responsible or official control.

Nature, quoting from the *Civil and Military Gazette*, Lahore, states that the Indian Government has under its consideration a somewhat comprehensive scheme for the establishment of research laboratories in various parts of India, and the appointment of health officers to take charge of them. The present laboratory at Muktesar will, it is understood, be further developed and the staff increased, the establishment becoming the central research laboratory for India, and health officers will be appointed to the charge of laboratories at Calcutta, Madras, Bombay, Agra and Lahore, the new department of bacteriology being ordinarily manned by officers of the Indian Medical Service.

THERE has been an active and somewhat acrimonious discussion in the English journals in regard to the extent to which physicians receive commissions. It is said that in the United States physicians do not receive commissions from pharmacists to any considerable extent, but suit has just been brought by a San Francisco physician for $300, which he claimed as a commission on prescriptions sent to a druggist. Complaint is also made that some of the younger surgeons in New York ophthalmic hospitals receive commissions from opticians.

A MEETING of the Society of Engineers was held at the Royal United Service Institution,

Whitehall, on October 2d, Mr. John C. Fell (President), in the chair. According to the account in the London *Times*, a paper was read by Mr. J. Bridges Lee on 'Photographic Surveying.' The author set out in detail the special advantages of the photographic method. Among these advantages are: (1) A more complete and accurate record than can be obtained by any other means; (2) saving of time in the field; (3) ability to take full advantage of short clear interludes in unsettled weather; (4) special advantages for military purposes in an enemy's country; (5) utility for travelers rapidly traversing a country; (6) usefulness for detecting geological and physiographical changes; (7) economy in operation. The author then passed in review the various kinds of photo-topographic apparatus which had beeen designed and constructed, pointing out the distinctive features of most of the best known instruments. All the best photographic survey work everywhere had been done with plane projection instruments. The author described the improvements made by him, designed to facilitate the subsequent interpretation of the photographs. These improvements consist of certain mechanical appliances inside the camera for securing an automatic record on the face of every picture taken of the horizon and principal vertical lines, of the compass bearing of the optic axis or principal plane, of a scale of horizontal angles applicable to all points visible in the picture, and of memoranda of useful information relating to the particular picture.

REUTER'S AGENCY reports that Dr. Carl Peters, the explorer, left Portuguese territory at the beginning of August, and crossed into Mashonaland, taking with him two of his prospectors, Messrs. Blocker and Gramann. The rest of his expedition he left in the neighborhood of the ancient ruins re-discovered by him near the Zambesi. He expresses his intention of establishing a permanent station on the Inyanga Highlands, and from that point of exploring the whole of Mashonaland from north to south. Besides gold, Dr. Peters claims to have discovered mica, saltpeter, and diamonds in a district practically uninhabited at an altitude of 8,000 feet, and, he believes, easily capable of cultivation. As the rainy season is now setting in Dr. Peters will, after exploring some districts on the Pungwe River, proceed to Beira *en route* for England.

AT a special meeting of the American Forestry Association at Columbus, in connection with the meeting of the American Association, resolutions were adopted recommending:

1. The creation of an international commission, through M. Meline, of Paris, to arrange for a Congress of Forestry at the Paris Exposition of 1900.

2. The purchase and reservation, by the State of Ohio, of tracts of timber land at the headwaters of the principal rivers of the State in order to prevent the increasing loss of life and property by flood, and for the better preservation of a water supply in time of drought.

3. The establishment of colleges and schools of forestry in the various States, with as much assistance as possible, in encouragement of the work, from the Department of Agriculture.

4. Commending the policy adopted by the State of Pennsylvania in the appointment of an expert forester to organize and conduct the forest interests of the State, and to educate its citizens in practical forestry.

5. Urging the suitable presentation of the subject of forestry at the meetings of teachers' associations, farmers' institutes, and other similar gatherings, "to the end that the people may be taught to give earnest attention to this much-neglected, but vitally important interest."

THE Vienna correspondent of the London *Times* writes that the trials of the system of rapid telegraphy invented by two Hungarians, MM. Pollak and Virag, which took place between Budapest and Berlin at midnight on September 29th, are represented to have practically justified the claims made on behalf of the new process. The experiments were conducted at both ends under the personal direction of the inventors in the presence of experts, including representatives of the Hungarian and French governments and one of the American cable companies. These are alleged to have given the extraordinary result of a transmission of no fewer than 220 words in ten seconds without prejudicing the clearness of the message. A perforated roll of paper, similar to that at present in use, is employed for the dispatch of the message, which is made visible and fixed photographically at the receiving station. Instead

of the dashes and dots of the Morse alphabet, there are rising and falling strokes starting from a horizontal line. The receiver consists of a telephone fitted with a small concave mirror, upon which are reflected, in the form of streaks of light, the impulses marked on the membrane. By an ingenious arrangement, recalling in some respects that of the cinematograph, the streaks of light reflected upon the mirror are reproduced upon a roll of sensitized paper, thus giving a narrow oblong picture, which in the present stage of the invention is developed and fixed like any ordinary photograph.

WE learn from the *Electrical World* that a singular decision has been made in the Senate of the Supreme Court of the Empire of Germany. Last December three mechanics attached a wire to a cable laid in the house where they lodged, and stole electricity enough to light their rooms. The Provincial Court sentenced them each to one day's imprisonment. The decision was based on the principle that electricity possessed the essential properties of a movable object. It has gone from court to court, and now the Senate holds that the judgment of the Provincial Court must be quashed on the grounds that the law provides only against the theft of movable bodies, and the court holds that those properties are wanting in electricity which would be necessary to constitute it a movable object in the sense of the law. The sentence states that electricity must be regarded as one of the energies of nature, like sound, light and elasticity. It was also decided that damage to property cannot be pleaded, for that requires that the substance of the object must be affected. Again, it was held that property has been withdrawn from the wire, but the Senate denies this, for electricity is not one of the properties of copper wire, so it is unanimously concluded that the law as it is in Germany tapping an electric current is not theft.

UNIVERSITY AND EDUCATIONAL NEWS.

DR. ARTHUR TWINING HADLEY was duly inaugurated as president of Yale University on October 18th, in the presence of a distinguished audience, representing the chief universities of the United States. Dr. Hadley took the oath of office and made the inaugural address. Professor George P. Fisher, of the Divinity School, made the congratulatory address on behalf of the faculty.

COLONEL RUTHERFORD B. TROWBRIDGE has given $10,000 to the Art School of Yale University.

FUNDS are being collected for a graduate fellowship at Mt. Holyoke College in memory of Elizabeth Miller Bardwell, formerly director of the astronomical observatory.

THE committee appointed by the National Educational Association to consider the plans for a National University at Washington will meet in that city on November 2d. The committee consists of President Wm. R. Harper, Chairman, President Alderman of the University of North Carolina, President Angell of the University of Michigan, Professor Butler of Columbia University, Dr. Canfield of Columbia University, Mr. J. L. M. Curry, Washington Agent of the Peabody and Slater Funds; Superintendent Dougherty of Peoria, President Draper of the University of Illinois, President Eliot of Harvard University, Professor James of the University of Chicago, Superintendent Maxwell of New York, Professor Moses of the University of California, President Schurman of Cornell University, President Wilson of Washington and Lee University, and Superintendent Soldan of St. Louis.

COMMERCIAL education was the subject for discussion at the sessions of the International Commercial Congress on October 28th. President Low, of Columbia University, presided. Addresses were also made by President Eliot, of Harvard University, President Schurman, of Cornell University and President Harrison, of the University of Pennsylvania.

A SPECIAL committee has presented a report to the general meeting of the Convocation of the University of London. The following are among its recommendations: (1) There should be only one faculty of science with adequate representation on the Senate and the Academic Council. (2) Engineering should be a distinct branch of the one faculty of science and not a

separate faculty, but degrees should be given in engineering bearing a distinctive name. (3) If it should be thought expedient to constitute a distinct branch of the faculty of science for any other scientific profession, there is not, in the opinion of my committee, any present occasion for giving a distinctive name to degrees to be taken in that branch. (4) If, contrary to the opinion of the committee, the subjects of the faculty of science should be divided by the commissioners, for electoral purposes, into several faculties, the committee hope they may be afforded an opportunity of giving further consideration to the principles upon which such division should be effected, especially in connection with the effect which the division would have upon the University examinations and degrees. (5) With regard to the position to be occupied by the art or profession of teaching, the committee think that this subject should find its place as a branch of the faculty of arts. (6) With regard to the proposal which has been made in more quarters than one to constitute a new and separate faculty for economic, commercial and social subjects, including, perhaps, administrative law, the majority of the committee think that this proposal is justified by the wide range and high importance of the subjects concerned, and the great and growing interest which they now attract. (7) With regard to the proportional representation of the faculties on the Senate and the Academic Council, the committee think that if the distribution of the faculties should accord with their suggestions the 16 representatives should be allocated as follows: To the faculty of science 5, arts 4, medicine 3, law 1, theology 1, music 1, economics 1—total 16.

According to *Nature* the work of the South African School of Mines, Kimberley, is now carried on in suitable premises, which were completed in the beginning of this year at a cost of about 9000*l*. Of this sum 2000*l*. was given by the Government of Cape Colony, 2000*l*. by the De Beers Company, and 5000*l*. was borrowed. The school has been established to carry out part of a scheme for the training of mining engineers in South Africa. The courses of instruction are intended to prepare students for a diploma of mining engineer, or for the degrees of B.Sc. or M.Sc. in mining engineering. Theoretical and practical instruction is given, under the direction of the principal, Mr. James G. Lawn, in mining, mechanical and electrical engineering, metallurgy, assaying, surveying and other subjects. Practical work is carried on in the mines and workshops of the De Beers Company, and also in various mines at Johannesburg. The time spent at Johannesburg is devoted to a special study of the cyanide process in all its developments, of the electrical machines and appliances at the mine where the student is working, of the methods of assaying and surveying, and of the economics of mining on the Rand. A thorough training for mining engineers is thus provided in connection with the school, the course of work described in the prospectus being of a very satisfactory character.

Teachers in Philadelphia public schools will hereafter be allowed to take their classes for a half day once or twice a year to the Zoological Gardens and Fairmount Park, the visit being regarded as part of the regular class duties. The managers of the Zoological Gardens have supplied a large number of tickets for this purpose.

Andrew Gray, M.A., LL.D., F.R.S., professor of physics in the University of North Wales since 1884, has been appointed professor of natural philosophy in Glasgow University, to succeed Lord Kelvin. Professor Gray graduated from the University of Glasgow and was afterwards assistant to Lord Kelvin.

J. S. E. Townsend has been elected a fellow of Trinity College, Cambridge. He submitted papers on 'The Magnetization of Liquids' and 'Electricity in Gases and the Formation of Clouds in Charged Gases.'

Dr. W. E. Dixon, late Salter's Research Fellow in pharmacology at Cambridge University, has been appointed assistant to the Downing professor of medicine, and Dr. L. Humphry has been made assessor to the Regius professor of physics.

Dr. W. König of Frankfurt has been called to an associate professorship in the University of Greifswald. Professor G. Sclavunos has been made professor of anatomy and director of the Anatomical Institute at Athens.